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BRITISH FOUNDRYMEN'S ASSOCIATION.

CONVENTION IN MANCHESTER.

THE first annual convention of the members of the British Foundrymen's Association was held in the Chemical Lecture Theatre at Owens College, Manchester, on August 2nd. The association, consisting of managers, foremen, and others in responsible positions engaged in foundry work, was formed for the study of metals, and for the purpose of discussion and of acquiring and diffusing a higher knowledge of the trade and its allied interests. The promoters felt that if they were to keep in the front line of progress they would have to discard indifference to scientific fact, as they are conscious that the industrial future lies with the people most highly trained in the arts and sciences applicable to practical work as well as in practical work itself. With these objects in view the association was formed, and the convention held in Owens College was the first since its inauguration, but it is intended that it shall be an annual event.

The members were formally welcomed on behalf of the Lord Mayor.

We are only able to briefly report the proceedings this month, a full report, with copies of the papers read, will appear in next month's issue.

In his presidential address, which was of a practical and suggestive character, Mr. Robert Buchanan outlined the hopes and possibilities of the association. It

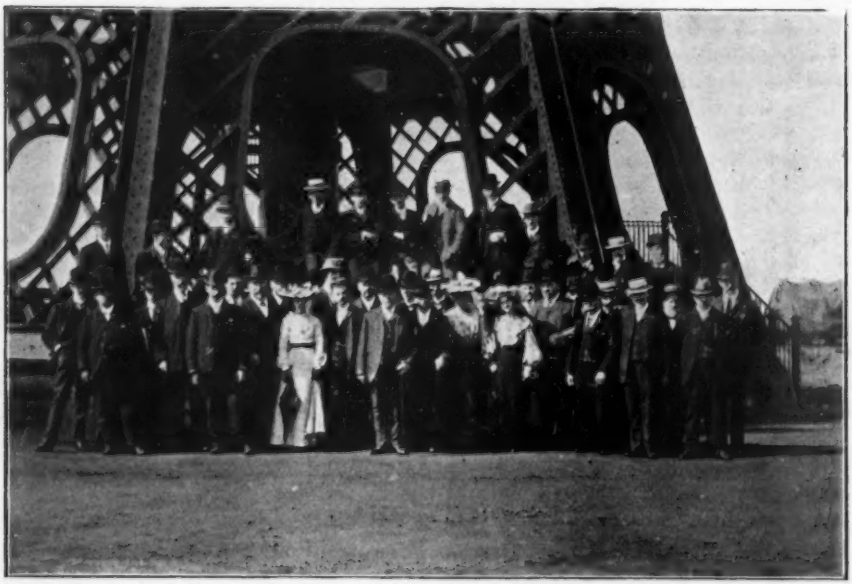
had no politics, he said, and it would not interfere in any way with the relations between employer and the employed. They met simply as students to acquire and to give knowledge; to apply to one work the lessons and the experience of other branches, and so reinforce general knowledge. Alluding to the educational methods of the present day, and the need for more technical education, the president cited the assertion of an American gentleman, that the British methods of primary education were so defective and futile that there was no foundation on which to build technical education. There was, the president confessed, some truth in the sweeping assertion.

His earnest hope was that all whose function it was to minister to the educational requirements of the country would so change the methods that there would be such a blending of ordinary and the technical education that the youth of the country would be equipped fully for doing the highest form of work, and doing it consistently and well. The president then proceeded to point out the necessity for study, and acquiring the most valuable information touching their trade, or calling, or profession, for without education no one might expect to rise above the dead level of a drudge. (Applause.)

The president, continuing, denounced the gambling evil. Whenever they saw a workman rush at the meal hour for a betting slip they might put it down that that man was an indifferent workman and an indifferent servant. He hoped masters would do their utmost to discourage the evil. If they were to maintain their position amongst the industrial nations, it was by earnestly and persistently attending to their work, and not frittering away their time on the things that perish. (Loud applause.)

A vote of thanks was conveyed to the chairman for his able address.

The secretary's report was read, and a



British Foundrymen's Association's visit to Westinghouse Works, August 3rd, 1904.

vote of thanks passed to the retiring officers.

The following new appointments were made: President, Mr. Robert Buchanan, Handsworth; Vice-president, Mr. Hubert Pilkington, Sheepbridge Iron Works, Chesterfield; Secretary, Mr. F. W. Finch; Committee: Messrs. C. Morehead, Rugby; F. C. Shaw, Birmingham; Percy Longmuir, Wm. Vickers, Birmingham; J. Ellis, Woolston, Hants; J. G. Stewart, Urmston; F. J. Cook, Birmingham; W. Roxburgh, Kilmarnock; T. McFarlane, Horsehay; R. Mason, Birmingham.

After an interval for luncheon, a paper on the "Structure of Metals and Alloys" was read by Mr. Percy Longmuir, Carnegie medallist. A second paper on "Strength Tests of Cast Metals," was contributed by Mr. W. T. Moccall, of Manchester.

The other engagements included a smoking concert on the night of the 2nd, and on the following day visits to the Westinghouse Works, Trafford Park, and to the works of Messrs. Craven Bros., Redditch.

A very interesting group was taken of the visit to the Westinghouse Works which we reproduce.

PORTRAITS OF PIONEERS.

VIII.—Joseph Hall.

JOSEPH HALL, of Tipton, South Staffordshire, was the chief pioneer of the modern system of producing wrought-iron by the "wet-puddling" or "pig-boiling" process.

From an interesting letter written by him it appears that he was born "about 1789." In what he considered his seventeenth year, he left home to seek his fortune; he found an employer, and was duly apprenticed. After becoming a journeyman he remained in the same situation, and was always zealous in promoting the best interests of the concern. Observing one day his master carrying into the work an old shoe-heel studded with hobnails, he watched, and was surprised to see him throw it into the molten metal in the refinery. That, he ascertained, was to utilise the old iron. That lesson in economy was not lost on Hall; he, too, began to gather scrap, and in course of time accumulated a goodly heap of scrap-iron, and some of the contents of the puddlers' boshes. These unconsidered trifles he charged into a

Mr. Joseph Hall.

puddling furnace on a Saturday, thereby taking advantage of the hot furnace and the quiet of the works. The "boilings" of the first experimental charge overflowed the fire and the flue bridges, ran through the stopper hole, and frightened Hall so much that he inwardly resolved not to repeat such a trial. The superiority of the product, however, was such that, aided by a few of the best of his fellow workers, he did try again and again.

Hall claimed—and the claim has not been seriously challenged—that he was the one who originated (a) the pig-boiling

system, (b) the method of framing the furnace bottom in cast iron plates with projecting ribs, and (c) the preparation and use of *roasted* tap cinder (familiarly known as "bull-dog") as a refractory material for the fettling or working lining of the puddling furnace. These splendid improvements, evolved in regular sequence, were the fruits of "thirty years of hard toil of the body and mind," Their results were most important.

Joseph Hall was associated with the famous Bloomfield Iron Works, Tipton, for many years. The partners to whom the business belonged at one time were Messrs. Bradley, Barrows, & Hall, and the wrought-iron bars marked with a crown, and bearing the brand "B. B. & H," are amongst the best-known to this day. Hall belonged to the good old-fashioned school of iron-masters. Living in a comfortable house adjoining the works he exercised direct supervision. And if by day or by night the helves did not keep up constant rhythm he was soon on the spot.

When about sixty years of age, Hall retired from active business, carrying with him from the conflict a sightless eye occasioned by a spark of iron. He had acquired, notwithstanding expensive litigation, "a sufficiency of the world's goods, to satisfy and surpass his most sanguine expectations." The shrewdness of his wife saved that competency, otherwise he might have been ruined.

Of a devout nature, having an active brain and a poetic temperament, Hall passed many of his latter days in contemplation and writing. His death took place in 1862.

Puddling is to-day, despite the advances in iron-making, carried on at home and abroad by Hall's system of pig-boiling. That world-renowned material, Staffordshire treble-best iron, is still manufactured by Hall's method—a method which brought within the range of possibility the utilisation of phosphoric British ores in the production of reliable malleable metal, and was an essential factor in maintaining Britain in the foremost position amongst industrial nations.

WALTER MACFARLANE, F.I.C.

NOTES ON AMERICAN TYPE OF FURNACES.

THE first point that strikes one about American blast-furnaces in general is the large output their managers get from them. This may be explained by the character of the ores used—most of them easily reducible (such as those from the Lake Superior district) again—the good class of coke obtainable, and, lastly, the high pillar of blast usually blown.

An American reasons that a blast-furnace lining is good for a certain output, and so why not get that output in the shortest possible time. His aim is to have uniformity in everything appertaining to the furnace working, a constant quality of ore—the less changing and chopping of burden the better—regular temperature of blast, and the blast supply governed by the number of revolutions of the blowing engines. Taking a general view of their type of furnaces, we find the hearth protected by heavy steel jackets reaching two to three feet below the hearth level. The tuyeres and tuyere bonnets are carried in a steel collar, and all their several joints are carefully machined. The tuyere bonnets, tuyeres, and cooling blocks are of copper, the copper they are made of showing a very low percentage of impurities.

The columns carrying the stack of the furnace are carried right up to the top of the bosh—this allows for good circulation of air and also easy access to the cooling plates.

Tuyere bonnets and cooling plates are kept flush with the furnace lining, the tuyeres projecting, according to circumstances, from four to eight inches into the crucible. The average tuyere diameter is

about six inches, the smaller tuyeres driving the blast further into the furnace whilst those of a larger diameter allow a greater volume of blast to pass up the furnace walls. Owing to the higher pillar of blast blown, and the ready market for low silicon pig—the hearths are made wider than in this country. Each furnace is isolated and has its own blowing engines and stoves.

Blast engines are, as a rule, of the compound quarter crank type and stoves of the Cowper-Kennedy pattern. Blast temperatures are not kept too high but regular heats are aimed at. Little appears to have been done in America in using blast furnace gas in gas engines, and consequently cleaning the gas. Several firms in this country are laying down extensive gas blowing plants, and providing the calorific power of the gas and the cleaning of it is satisfactory, then, there seems to be no reason why it should not be a success. When one thinks that for every ton of coke burnt in a blast furnace we get six to seven times the weight of gas off, and even if one half of this gas is used for heating stoves, we can readily see that there is a large source of power left for blowing purposes, generating electricity, etc. A gas engine using furnace gas requires from 100 to 130 cubic feet of gas per h.p. per hour, and the calorific power of the gas ought not to be less than 950 calories per cubic metre at 0° C. and 760 minimum pressure.

Clean gas is also conducive to a more regular blast temperature. Working with dirty gas the chequer work in the stoves gets coated with flue dust, this coating is a bad conductor of heat, and consequently the heat does not penetrate into the brickwork. A dirty stove put on blast, drops its heat very quickly, until the flue dust coating has given off its heat then the blast derives its heat from the brickwork, and the heat, although low in temperature, is more steady.

Another notable improvement in American practice is the method of charging the furnace, a method which dispenses with the usual fillers and chargers, and in addition is much quicker. One arrangement is as follows: An electric lorry runs under parabolic bunkers or alongside the hoppers, carrying its own weighing arrangement and drawing its charge of coke, ore, and limestone as required; when full it runs over the skip pits and by means of a bottom door discharges its contents into the skip. The skip is now hauled up the elevated track to the furnace top, the back pair of wheels on the skip are made double, so that when the skip reaches the top these outer wheels which usually run free engage outer rails which are so bent that the rear of the skip rises and its contents are tipped into the distributor; the skip now runs back and is braked to the bottom, and on its return journey a ratchet gear comes into play. The spout of the distributor is revolved about a quarter of a circle and the charges so distributed around the bell.

The bell is lowered by the hoist engineman, but before it lowers the flap over the distributor spout closes, and so prevents undue escape of gas. There are four rods permanently fixed in the furnace, and, by suitable reducing gear, the number of feet the furnace is down may be readily seen both in the hoist engine-house and at the furnace bottom. The hoisting plant and distributing gear is made by the Brown Hoisting Company, Ohio.

J. E. TORBOCK.

THE SELECTION OF MOULDING SAND.

H. S. VROOMAN a well-known authority on foundry matters, makes the following observations on the above subject:—

In the selection of a moulding sand there is no rule that can be laid down for the selection of sand for a particular grade of work, as all foundries differ some in their operation and practice. A sand that

suits one foreman another cannot use or would not have. This is not a difference in ability, but in conditions. A sand used in different shops under like conditions will give like results, but under different conditions will not give like results. Every practical man in the foundry business has his ideal in a moulding sand, although he is seldom able to obtain it. We frequently hear certain sands spoken of as being the best sand. Yet, if a visit could be paid to the foundries in the district that this sand comes from, you would find the percentage of loss would be the same as elsewhere. These losses will occur in the best shops with the best of moulding sand. The only thing that can be done is to keep them down to a minimum, which can be done with a sand suitable for your work. In ordering sand, allowance must be made for variation, as it is hardly possible you will receive any two shipments that are exactly alike. This variation is due to the way sand lays in the pit. Sand deposits, in most cases, are but pockets, being washed in at some time by a flood or overflow, and are usually found in the vicinity of streams or bodies of water. Some deposits contain two and even three grades of sand. These are all mixed together as a whole and shipped, unless the different grades are so separated that they can be mined separately.

Moulding sand is really manufactured at the pit, and it is the ability of the shipper in the manipulation of the sand to put it on the market to suit his customers, and a shipper that understands his business will be able to deliver regularly a good average grade of sand. The time of the year at which sand is dug will make a difference in the quality. A sand digs best when it is of a temper to work, containing just enough water to mix well and soften up easily. Wet sand will not mix well, as the alumina rolls down and sticks together, neither is sand that is dug dry good, as the alumina is dried up in lumps and cannot be broken. If it were possible to dig sand and allow it to weather out over winter and ship it the following season, it would be of much more uniform quality. The expense attached to this method of loading sand would increase the cost too much and the foundries would not want to pay the difference. Not being able to lay down a rule for the selection of a sand for different grades of work, owing to the different conditions under which it is used, the question then arises: What is a good moulding sand? What kind of sand shall be selected and how shall this selection be made? To begin with, a good moulding sand will resist the pressure of the liquid metal, give free escape to the gases, separate easily from the castings when cool, leaving a clean smooth surface. To fill the first requirement, the sand must contain sufficient alumina or bond to resist the pressure of the liquid metal. This must be kept within reason or it will not permit the free escape of the gases. The amount must be determined by experiment. Some kinds of work will burn out sand faster than others and will require a sand higher in alumina, etc. All sand will burn out or lose its plastic nature at a red heat and to the extent that a sand becomes red-hot from the face of the mould, to that depth will it burn out and become a loss and to that amount must be renewed; and while on that point it might be well to say that a sand heap should have a little new sand every day. The theory held by some that the new sand that is put into the facing sand is enough to keep the heap in good condition is wrong. There is nothing as hard on sand as sea coal. This facing sand is all brought in contact with the melted iron and if it does not burn out from contact with the casting it is burned out from the sea coal taking fire and the passage of gases through the pores left open by burning out of the coal.

The renewal of a sand heap is a thing which should be looked after carefully, as many losses that are laid to the sand are

the result of bad sand heaps. This renewal should not be left to the men, but should be seen to by the foreman, and the proper amount of new sand put into the heaps every day. The more open a sand is the easier it will separate from the castings. To secure a smooth face use as fine a sand as you can without it burning on to the face of the castings. It is advisable to use as open a sand as you can without it cutting, as an open sand will carry more water, which will aid in giving better lifts and clean draws. You can ram it harder, which will keep the casting down to weight, and it will vent easier. In making a test of a sand a thorough trial should be given, and when failure is met with an analysis of the causes as well as the composition should be made and the exact fault located. It may be found under careful scrutiny that a sand you would condemn offhand may be used to advantage when it is thoroughly understood.

In making the analysis of sands, three determinations are all that are necessary—(1) alumina, (2) free silica, (3) loss on ignition. The alumina denotes the strength or wearing qualities, free silica the openness or porosity, the loss upon ignition the water of crystallisation and vegetable matter. To this might be added a determination for iron; sand that is very red in colour will analyse high in iron. Iron adds a further bond to the sand in addition to the alumina, without closing up the pores. Impurities, such as lime and magnesia, as a rule do not exist in sufficient quantities to do any harm, and can be ignored.

After you have decided on about the grade of sand you want to use, you may then have trouble in finding what you want. The next move is for you to buy two or more grades of sand and blend them. This is the only solution of the moulding sand problem and the one way for the foundry men to get good sand and one containing the proper percentage of the different elements. By this method a coarse sand can be made finer by the addition of fine sand, and a fine sand can be made coarse by adding coarse sand, &c. Your percentage of alumina can be increased or decreased at will by adding open or strong sand in proportions to suit your work. By blending I do not mean to buy two or three grades of sand and put them all in one bin or shed, or put them in different sheds and allow the moulder to dig into them at will. These sands should be bought differing in composition and structure to the extent that they may be used separately on some of your work and when mixed together will give you a sand that you can use generally. The blending process should be done with a mechanical mixer, a machine that every foundry should have. This should not be a machine that will throw the sand out as fast as it is put into it, but a machine that will mix it thoroughly. Care should be taken in mixing and the proper proportions used. Mix by measure and not by weight, as one sand may contain more water than the other and would weigh more. Should your sand be unsatisfactory for any reason in the blending process, you have the means at hand by which you can remedy the trouble at once. You do this in your mixture of iron, why not in sand? Local sands are not always suitable for local work, but by the blending process an inferior local sand can be built up by mixing with it a good foreign sand.

NOTES AND OBSERVATIONS ON CAST-IRON.*

By J. E. Johnson, Jun.

THE difference between cupola-metal and furnace or direct metal is, first of all, in the lower average sulphur-content of the latter. It has been proved by experiment that iron increases in its content of sulphur to a considerable extent with each remelting. More than thirty

* Abstract of a paper read before the American Institute of Mining Engineers.

years ago Fairbairn showed that a certain iron after remelting eighteen times had only five-eighths of its initial tensile strength and stood one-third of its original deflection, though there had been a decided increase in both up to the twelfth re-melting. He did not show the cause of these results, but they undoubtedly were due jointly to increase in the content of sulphur and combined carbon.

It is easy to calculate that, if iron be remelted with a coke containing a normal quantity of sulphur, say 1 per cent., with a melting ratio of 10 to 1, and if only half of the sulphur goes into the iron, the increase in the sulphur-content of the latter will be 0·05 per cent., which, according to the usual specifications, is the maximum amount the iron is permitted to contain, as it comes from the furnace.*

The reasons for the higher heat of the furnace-metal are—first, that the ascending current of gases has a much lower temperature in the cupola than in the furnace because of the use of cold blast in the former. (This might be overcome in practice by the use of an excessive quantity of fuel, but it would require more than would be commonly supposed); and second, and more important, that in the cupola the iron is exposed to the hot gases for a much shorter period, and is consequently unable to approach as closely to the temperature of the gases as it does in the furnace, to say nothing of the temperature being lower in the former than in the latter.

Some foundrymen have had experience in making workable castings from furnace metal of a silicon-content which if present in iron cast from the cupola would put machining out of the question, and this leads to a contention that the hotter the metal is poured, the softer the casting.

This experience can be confirmed. It is, and has been for years, the practice of the works with which I am connected to make, for repairs, as well as for new construction, all castings within the reach of their moulding facilities, directly from a furnace producing "basic" iron, with the silicon guaranteed under 1 per cent. and the sulphur under 0·05 per cent. The iron would perhaps average, the year round, sulphur 0·03 and silicon 0·7 per cent.; and yet there are comparatively few days in the year when the ordinary run of castings may not be made without fear of their being too hard to be machined. Of course, when the furnace produces white-iron showing white clear through the pigs (which are cast in chills), it is necessary for the foundry to work on castings which do not require to be machined. On the other hand, should the iron contain much above 0·9 per cent. of silicon, difficulty is experienced in preventing holes and soft places in the castings, caused by the deposition of graphite or "kish" during or after pouring.

The best way to mitigate or prevent this trouble, which is sometimes very annoying, is to pour the iron very hot when making pieces of small or moderate size. The effect is to chill the metal from a high heat by contact with the cold mould and reduce it to the solid form as quickly as possible, thus preventing, to a great extent, the formation of graphite while the iron is molten, which gives rise to the kishy places. The graphite formed after solidification is distributed more or less uniformly throughout the metal; whereas, if the metal is allowed to cool to some extent before pouring, graphite begins to form within it, and separates out at eddies and high points of the mould, with objectionable results.

It is impossible to discuss this subject satisfactorily without making use of the well-established fact that cast-iron being a member of the same series as steel, the principal effects in it are due, as in

* In a later portion of this paper will be found a few observations on the mitigation of this evil.

steel, to the quantity of combined carbon it contains. If the graphite, which is merely emmeshed in the cast-iron, were absent, the latter would be, in fact, an impure steel, containing in general more silicon and (excepting Bessemer pig) more phosphorus than ordinary steel.

The acceptance of this view renders available for the study of cast-iron an enormous amount of material gathered from both practical and theoretical sources through many years, for the solution of problems presented by steel, in fact, the work done upon steel furnishes a solid foundation for the study of cast-iron. This, indeed, seems quite the natural order, since it proceeds from the simpler to the more complex compound.

A chart of the "freezing-point curves" of the iron-carbon systems, such as those of Backhuis-Roozeboom and Roberts-Austen, shows that, with a pure cast-iron containing more than about 4·3 per cent. carbon, there is a range of temperature within which carbon must separate out in the form of graphite before solidification takes place; this range of temperature being closely proportional to the excess of carbon above the quantity mentioned, roughly 100° F. for each 0·5 per cent. carbon.

It, then, we had to deal with a pure iron containing, say, 5 per cent. of carbon, it is obvious that carbon in considerable quantity would have to separate out of the iron during cooling in the molten condition, and, naturally, that some of it would pass off into the air, especially in the ordinary operation of casting from a furnace, in which the running of the metal affords every opportunity for the liberation of this graphite. But, as there is little or no iron made containing 5 per cent. of carbon, this explanation alone is insufficient.

The diagram of freezing-point curves referred to shows that with all pure cast-irons the separation of graphite continues for several hundred degrees below the point of solidification; and it has been proved by direct experiment that silicon exercises a powerful influence in assisting or compelling the formation of graphite in this temperature-range (a fact also well known in practice); also that it lowers very markedly the temperature at which the separation of graphite can begin, and reduces the quantity of combined carbon with which the iron can be "in equilibrium."

That this action of silicon on the formation of graphite persists above the point of solidification is proved clearly by its action in relation to suddenly cooled or chilled castings. It is well known that in the presence of more than 1·5 per cent. of silicon it is impossible to obtain any chilling action, and that, other things being equal, the strength of this action is inversely proportional to the quantity of silicon present below that amount.

So much being established, it may be taken as certain that silicon has the same effect in lowering the temperature and the percentage of combined carbon at which the cast-iron is in equilibrium above, as well as below, the point of solidification. It thus lowers the percentage of carbon above which graphite is forced to separate out from the still molten iron, and this accounts for the observed fact that, at a furnace running on foundry-iron, the cast-house is often full of kish, while at a furnace running on low-silicon iron this is seldom seen, though the carbon-content of the iron is as high (or higher) in the second case as in the first, and the iron may show a beautiful grey fracture when slowly cooled.

Many interesting facts have been developed as a result of using iron, the composition of which is at the extreme limit permissible for foundry-work. Castings are sometimes made from iron, of which it is known that the machining will be, at best, barely practicable; yet it is necessary to save them if possible. For such cases a very slow cooling has proved

efficacious ; the castings are buried in hot sand and kept there over night, or even for a whole day, if they are large, and able to hold their heat for this length of time. Of course, the slow cooling is practically identical with the annealing of tool-steel, with the additional condition of the separation of graphite.

The reason for the absence of kish in ordinary cupola foundry-work is, that the metal, having a temperature considerably lower than that of furnace-metal, has to pass, in cooling, through a much smaller part of that range above the melting-point, within which graphite is compelled to separate out. Consequently, there is little or no formation of graphite during the melted state, and hence no kish. This fact does not prevent the iron from being very graphitic when cold, because, as shown by the freezing-point curve, the separation of graphite continues for several hundred degrees below the temperature of solidification.

It may be added that for each kind of cast-iron there is a maximum of carbon which it can contain dissolved when it "sets," though much of this carbon consequently passes into graphite in the solid state. Any excess above this limit will be expelled in the form of graphite while the iron is still liquid. This maximum represents, in fact, the eutectic of iron and carbon for that kind of cast-iron. The limit of carbon for pure cast-iron is 4·3 per cent., as already stated, and diminishes with progressive increase of silicon.

If, for convenience, iron containing more than this amount of carbon be called supercarbonised, and any increase in temperature above the melting-point of the eutectic be called "superfusion," it may be said that "kish" is formed when a supercarbonised iron is superfused.

It may be said that kish is formed by molten iron, while graphite is formed by solidified iron, and it must be noted that kish can be formed only when the quantity of silicon present is sufficient to cause the carbon dissolved in the iron to supercarbonise it.

It is impossible to emphasise too strongly the influence of time in all these matters. This is well understood with regard to steel, but seems never to have been thoroughly realised with regard to cast-iron, in which most of the changes common to steel occur, as well as those incident to the formation of graphite.

The diagrams of freezing-point curves before mentioned, which show the cooling-curves and the internal changes of steel, are always based on the condition of slow cooling, therefore do not directly represent the effects of quick cooling.

Such a diagram, therefore, does not directly exhibit the results of the chilling effect of the mould on hot-poured metal. Yet it does show plainly that denying the time required for the separation of kish from the super-heated metal increases the carbon-content of the iron at solidification. This seems to me to indicate further that quick cooling raises the temperature of solidification, and consequently increases the range, both of temperature and time, during which graphite is formed after solidification. Hence a hot-poured iron tends to be less kishy and more graphitic than if poured at a lower temperature.

These conclusions are confirmed by practice. Hot-pouring to prevent the formation of kish has been mentioned already. It may be added that, of castings made from some kinds of furnace-iron, those first poured from the ladle are entirely free from kish, while those poured last from the same ladleful are so kishy as to be objectionable.

So far as I know, these general facts and their fundamental relation to the accepted theory of the general subject have not been published hitherto.

It is worthy of note, in this connection, that hot-pouring tends to prevent the

production of hard castings from relatively hard iron, and of kishy castings from relatively soft and kishy iron. This may explain the strong insistence of foundrymen upon "hot" iron.

Concerning the formation of graphite, it must not be forgotten that the important question is not how much graphite is formed, but how much combined carbon is left.

Observations of irons habitually low in both silicon and sulphur-content make much plainer the action of the latter element than do those of irons further removed from the chilling point by the presence of more silicon; and it seems to me, as a result of several thousand such observations, that the harmful effects of sulphur have never been properly emphasised.

So far as I know, a lower sulphur-content than 0·05 per cent. is seldom or never specified in foundry or other standard varieties of iron, and yet an iron with 0·05 per cent. sulphur is no more to be compared with a similar iron containing 0·025 per cent. sulphur than coke-made white iron is to be compared with cold-blast charcoal-iron.

At the works above mentioned, as at many others, it is the custom to take from every cast a small chill-cast sample (roughly 1·25 in. by 2 in. in cross-section by 7 in. in length), remove it from the chill-box when it has cooled to a dull red, quench it as quickly as possible and break it.

When the furnace is running on basic iron of standard composition, these chill-samples will show from the faintest line of white at the lower corners, with 1 per cent. silicon and, say, 0·02 per cent. sulphur to dead-white with lower silicon and higher sulphur. Through a very large part of the range of analysis covering the best basic irons low in both sulphur and silicon, these samples are solid-white, and their variations in fracture, according to the sulphur present, are astonishingly great to be covered by the single title "white."

That sulphur, however, is the principal cause of these variations of physical properties is sufficiently proved by the fact that with experience it becomes perfectly possible to estimate the sulphur in the iron by the fracture of its chill-samples, and, as a general thing, to come within 0·01 per cent. of the laboratory determination.

With iron approaching 1 per cent. silicon the effects of sulphur are to some extent masked, but not completely. Its effect in reducing the size of the grain, increasing the depth of chill and blackening the colour of the grey part of the fracture is plainly apparent.

The exact internal effects of sulphur in steel have been clearly shown by Professor Arnold* and Mr. J. E. Stead,* and there is little or no reason to doubt that the action is the same in cast-iron. This action is to form a very fusible iron sulphide which remains liquid long after the rest of the iron has solidified, and disseminates itself between the grains of the iron, thus severing or weakening their continuity. It is not to be expected that silicon, for which sulphur has little affinity, should neutralise such an influence, whatever its effect may be in opposing that of sulphur on carbon. This point is of much importance practically, for the reason that much foundry-practice at the present time seems to be founded on the belief that silicon is a neutraliser of sulphur.

Since the quantity of sulphur in iron increases considerably at each melting, it is natural that scrap which has had at least one remelting will contain a high percentage of sulphur, and therefore will have a more marked tendency to chill, than furnace-iron; and as high-silicon iron will undoubtedly soften white-iron, it is perhaps natural to assume that the

* Various papers in *Journal of the Iron and Steel Institute.*

addition of the former is all that is necessary to soften scrap. Undoubtedly such an addition will counteract, wholly or in part, the chilling tendency; but it does not follow that this remedy will neutralise all the other effects of sulphur. When it is remembered, moreover, that the action of silicon in preventing the formation of combined carbon is certainly completed at, if not below, 2 per cent., the wisdom of using mixtures, which contain more silicon than this limit as they come from the cupola, is open to question, especially as silicon is a hardener on its own account, and beyond this percentage a weakener also. Silicon, when present in greater quantities than 2 per cent., is also a great dirt producer in castings. This matter of dirt production does not receive much attention in general; but I feel confident that many sand-holes in castings are due to silica, produced by the combustion of silicon in the cupola, and remaining suspended in the metal until the latter comes to rest in the mould, and gives a chance for the silica to separate.

The cleanness of castings made from low-silicon furnace-metal, as compared with those from ordinary cupola-iron, would surprise those who have not witnessed the difference.

Just how far silicon neutralises the evil effects of sulphur is one of the most important questions of foundry practice to-day, and should without doubt be investigated by some one able and competent to do it; preferably under the auspices of some engineering society.

Not much can be done to remedy high sulphur in the iron after it has passed through the cupola. The addition of manganese in some form in the ladle is the only method which has been tried to any extent; and it has yielded good results in some cases, though its use is open to various objections of a practical kind, such as the high cost of ferromanganese, which is practically the only form of manganese available for the purpose; chilling of the iron in the ladle, if the ferromanganese is charged cold; or the cost of preheating it, if it is charged hot. Nevertheless, there are many cases in which it could be profitably used, care being taken not to add too great an excess, and thereby increasing the percentage of manganese in the iron to a point where hardness would result.

So far as I know, calcium carbide has never been used for this purpose; but it is well worthy of a trial. It compares favourably with ferromanganese in cost, while its combining power and its affinity for sulphur are much greater; moreover, its decomposition would impart heat to the metal.

Much can be done, however, to prevent the absorption of sulphur by the iron in the cupola. The first step is, of course, to use iron and coke low in sulphur, the next is to use an iron containing considerable manganese, say from 0·75 to 1·5 per cent., since this quantity slags off the sulphur and prevents it from entering the iron. In the running of the cupola much can be done by slagging it freely, and there does not seem to be any reason why additions of lime should not be made in such quantity as to neutralise the extreme acidity of the slag. If from 1 lb. to 2 lb. of limestone were charged for every pound of silica in the coke-ash, the slag would be very fusible as compared with blast-furnace slags, but enormously more powerful in the removal of sulphur than one without lime. In a 10-ton heat with a melting ratio of 10 to 1 and coke containing 7 per cent. silica, there would be 140 lb. of silica in the charge, and 200 lb. of lime added to this would have a marked effect in reducing the sulphur-content of the resultant iron if at all excessive, at an utterly insignificant cost. A still more calcareous slag would be inadvisable, under the present conditions of cupola-practice, because, with the cold blast used, a sufficient temperature would not be attained to melt it. But this

brings up the question: Why are not cupolas blown with warm blast?

A calculation of the quantities of heat required and expended in melting iron, or an examination of the top of a cupola in operation, will show that there is plenty of available heat which could be utilised to save fuel. It has been calculated that from 25 to 40 per cent. in fuel-consumption could be saved by heating the blast; and this would permit the use of relatively calcareous slags which would reduce the sulphur-content and give better iron—results opposite to those obtained in general practice, when any attempt to economise in fuel is made with cold blast.

The means of heating the blast could be very simple, merely some wrought or cast-iron pipes located in an enlargement of the cupola-stack and connected by return bends, with external joints out of reach of the fire. The quantity of air admitted at the charging door would give a simple means of controlling the temperature and thus avoid any damage to the pipes. The blast would pass through the pipes in series on its way to the wind-box, and could probably be heated as hot as desired without difficulty and without excessive cost for repairs. The pipes would be exposed to no danger of being burnt up when there was no air passing through them, because at such times the cupola would not be going to any extent worthy of consideration.

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CHEMICAL SPECIFICATIONS FOR PIG-IRON.

By EDGAR S. COOK.

INDICATIONS all point to the substitution of classifying pig-iron by chemical analysis for the old-time method of grading by fracture. Commencing with the larger users, and the makers of specialties, who require more positive information as to the composition than is afforded by the fracture, the use of pig-iron, guided by analysis, has spread with much greater rapidity to all classes of foundry-work than the most sanguine expected.

Grading by fracture, as guided by experience with any particular brand of iron, has some points in its favour. The fact that for so many years castings of multitudinous forms, and for an endless variety of uses, were made in a fairly satisfactory manner by skilful guessing as to mixtures, shows that, for many classes of work a considerable range in composition may be allowed, without injuriously affecting the castings. But with accurate knowledge as to requirements, and more positive information as to the composition of pig-iron, there will doubtless be a smaller percentage of defective castings.

The opinion of the author, as expressed in a paper read before the American Institute of Mining Engineers, is that working by analysis, however, will not prove a panacea for all the ills of foundry practice. There are many causes affecting the success of such practice other than the composition of the iron charged into the cupola.

There are limitations also, to the ability of the blast-furnace to furnish pig-iron according to rigid chemical specifications without unduly enhancing the cost. In the long run the consumer must pay the cost and risks of manufacture, plus a fair profit on the capital invested; otherwise the supply will not equal the demand.

The manufacture of special irons

having a certain composition, with very narrow limits of permissible variation, demands special ores and special fuels, as well as uniform conditions of furnace-work. Such ores and fuels are not in abundant supply, and therefore command comparatively high prices; while the unavoidable "misfits" made by the furnace, and sold at less than cost, enhance the average cost of manufacture, for all of which the consumer must ultimately pay.

Blast-furnaces could be run with much more comfort to the manager, and with much better average results in every way, if it were possible to obtain absolutely uniform raw material, and if the atmospheric air driven into the tuyeres always contained the same weight of oxygen and of moisture per cubic foot. But if all the furnaces operating to-day were forced to demand ores of uniform composition, always the same in percentage of iron and gangue, and coke that did not vary in sulphur, phosphorus, ash and fixed carbon, most of them would be obliged to blow out; and the cost of pig-iron would rise to prohibitory figures.

The furnaces are obliged, therefore, to take raw materials as they find them, and, by judicious mixing, based upon an *approximate* knowledge of their contents, make as uniform a product as possible.

This product is the raw material of the foundry. It is a wise precaution, therefore, in substituting grading "by analysis" for grading "by fracture," not to draw the lines closer, nor make the conditions more severe than is absolutely necessary to meet the requirements of the particular class of manufacture concerned.

In this connection the author cannot do better than quote some remarks of Dr. R. W. Raymond:—

"This apparatus (the blast-furnace) is noted as perhaps at once the rudest and the most sensitive of the means employed in manufacturing on a large scale. In proportion to its rudeness and sensitiveness, it has always called for exceptional skill in management. The requirement of skill in this sense has been greatly diminished by the work of chemist and engineers during the last few years. But the hampering condition still remains, that these great furnaces, devouring hundreds of tons of raw material and producing hundreds of tons of pig-iron and slag daily, are required to preserve a certain chemical composition of product. This requirement is often inconsistent with the use of the cheapest ores, the maximum economy of fuel and the maximum product of iron."

Blast-furnace practice may be said to be in the "half-civilised" state. But the foundry is really most interested in knowing the exact composition of its raw material—pig-iron. This is more important than having it rigidly conform to any particular set of specifications, defining the limits of silicon, sulphur, &c. It is for the foundry-manager, knowing the composition of his raw material, to employ the scientific method, and, if unable to obtain one pig-iron meeting all his requirements, to make such a mixture of various irons as will produce the result he seeks.

The correct sampling of sand-cast pig, especially of the foundry grades, is troublesome and expensive. For a fairly representative sample, numerous pigs must be drilled with care. Even then, different samplings of the same lot of iron will show frequently, under the same method of analysis, widely varying results as to silicon and sulphur. This occasions misunderstandings, quite as difficult to adjust as disagreements with respect to the "fracture" indicating any particular "grade."

I do not refer only to controversies affecting the price, where judgment may be warped by money considerations. I have in mind several experiences of our own, illustrating the difficulty of arriving at the composition of sand-cast pig, when the question of price did not enter into the matter at all, as no particular guarantees had been made. The purchaser required reasonably accurate information to guide him in using the iron; and we co-operated

with him in sampling and making analyses All the samples were made by drilling about one dozen pigs to represent each lot of 50 tons. The comparative results were as follows :—

Comparative Analyses of Samples of Pig-Iron, taken by Drilling of Sand-Cast Pigs.

Silicon.	Sulphur.	Silicon.	Sulphur.
Per cent.	Per cent.	Per cent.	Per cent.
1·90	trace	0·964	0·045
1·23	0·04	0·926	0·045
0·85	0·09	0·855	0·050
1·71	0·035	0·880	0·040
1·08	0·040	0·910	0·060
1·03	0·06	1·010	0·080
1·04	0·05	1·08	0·050
1·31	0·04	1·19	0·04
1·50	0·03	1·09	0·06
0·62	0·05	0·74	0·04
0·87	0·03	0·80	0·04
1·21	0·04	0·92	0·07
1·04	0·05	1·08	0·05

The marked discrepancies in silicon were found to be due to particles of sand included in the samples, through lack of care in the drilling of the sand-coated pigs in the machine-shop of the purchaser. The iron sold was all "grey forge."

This experience led us to adopt the method of sampling iron liquid, as it ran from the furnace. It has been found more reliable, as fairly representing iron to be used in quantity, than the drilling of individual pigs.

Sometimes, consecutive casts of pig-iron prove to be remarkably uniform as to silicon and sulphur, the differences between the different beds not exceeding the permissible laboratory variation; but this is the exception rather than the rule. Phosphorus is generally evenly distributed. Segration does not seem to affect it, and there is seldom difficulty in determining it.

These illustrations show the difficulties besetting the accurate determination of the composition of sand-cast pig. When the situation is complicated by commercial considerations, it is evident that grading by analysis may not remove all friction of interests, though it is unquestionably an improvement upon grading by fracture, and certainly a safer guide as to the use of pig-iron. Fortunately, for most classes of foundry-work, moderate variations in the composition in carefully-selected foundry-irons are not fatal, because a certain range in chemical composition has been found permissible in practice.

THE IRON AND STEEL TRADE.

IT would be entirely out of place—notwithstanding the exigencies of space—to allow the Red Book recently published by the Tariff Commission, and dealing with the condition of the iron and steel trade, to pass without brief observation in these columns. It would, however, be obviously ludicrous to pretend to deal in the very limited compass of a trade journal with the numerous salient points which are so vividly presented to the readers of the report in question, for to do so would require an entire volume of this journal, and not the narrow space allotted for this purpose.

It would be difficult to conceive of many industries which have continued on the down grade to the same extent as has been experienced in the iron and steel trade of the United Kingdom, and it might be observed in this connection that the bulk of printed matter herein alluded to deserves to rank as epoch-making as regards the scientific investigation of the state of the British trades. It may be a matter of common knowledge—and those directly connected with the metallurgical industry know it to their cost—that in a single generation this country has receded from the top position as regards iron and steel making to one of third-rate rank.

Herein, surely, lies a deal of food for reflection, for unless the retrograde movement be arrested by some means or other, the prospect of the metallurgical industries of the future would appear to be of anything but an encouraging or

promising character; whilst those trades of America and Germany (to cite the two principal countries in question) will undoubtedly continue to outstrip us, as they have done in the past few decades.

As has been said, whilst it is regretted that it would be impossible to even touch upon here the many points raised in the volume referred to, yet those of our readers having the interest of their trade at heart would be well advised in pondering over the result of the Tariff Commission's deliberations and scientific investigations.

RARE OR REFRACTORY METALS.

(*Continued from page* 32.)

Aluminium.—On the other hand, aluminium speedily attracted attention owing to the fact that it differed from the preceding metals, inasmuch by the powers of resistance to alteration which it possesses. Like the foregoing, it is light, though it, nevertheless, possesses the useful properties of the ordinary metals which are three times as heavy as this is. It is also worthy of observation (continues *La Métallurgie*) that numerous endeavours have been made to render its manufacture more economical, remarkable results having followed these efforts, for the metal, which cost more than 100 fr. the kilogramme by the old methods, can be manufactured to-day at less than 4 fr., not being much dearer than copper was twenty years ago.

It has been due to electricity that this problem has been able to be solved. It is, moreover, by decomposing potash by the electric current that Davy first discovered alkaline metal. At that time, however, electricity was a very expensive commodity, being confined as it was to laboratories. Quite superfluous to add, to-day the development of all the electric industries enables the current to be employed as a relatively cheap agent of decomposition.

Electrical Processes.

Electrolysis by Igneous Fusion.—The method generally adopted in the manufacture of aluminium is directly inspired from Davy's classical experiments—being known as electrolysis by igneous fusion. A very powerful current is made to pass through a fusible salt; the heat which this current develops brings the mass to a red heat. Once the salt is dissolved, the electricity passes through it quite easily as a conducting matter, therein producing decompositions similar to those that are found cold in metallic solutions and which serve as a base in galvanoplasty. The metal is set free and is brought to the negative pole; the other elements, such as chlorine or oxygen, are given off at the positive pole.

Properties of Aluminium.—In spite of the low price (relatively speaking) to which this metal has now been reduced, it cannot be said that it is used as extensively for industrial requirements as might have been anticipated, the reason assigned for this being that its resistance to alteration is only apparent. Under the influence of air, aluminium will become covered with a very fine oxidised pellicle which scarcely tarnishes its brilliancy, and which protects it from outside influcences, so that samples of it can be preserved for an indefinite period without visible alteration. In practice, however, under the influence of damp air, industrial aluminium, which is not strictly pure, gradually becomes spotted and sometimes rapidly destroyed.

This phenomenon is produced even under coatings with which the metal may have been covered, and this metal will only be capable of rendering lasting services in a number of cases when some means is found whereby its surface can be protected, either by adherent metallic deposits or by a solid paint.

Extraction of Refractory Metals.—There are a number of curious metals, such as tungsten, molybden, vanadium, uranium, and litanium, which were known but imperfectly a few years ago. Not only

are their oxides not decomposable, but these metals do not melt at the ordinary temperatures, and they could only be obtained in the form of very impure powders. They have, however, now been isolated and melted by Moissan in the electric furnace, this celebrity having made a series of discoveries which constitute the greatest progress which has been made for some time in the chemistry of metals. Interesting as it would be to reproduce the particulars of the apparatus employed by Moissan to achieve his purpose, we are, nevertheless, precluded from doing so through increasing demands made upon our space. It may, however, be observed that a large number of electrical furnaces have been devised for carrying out these operations upon rather larger masses and under far less costly conditions. Up till now these new processes have not been attended by any very important trade results; the only product of the electrical furnace having a commercial interest at the present time is carbide of calcium.

AMONG THE FOUNDRIES.

Mr. William Samson, who has been connected with Messrs. A. G. Kidston & Co., 81, Great Clyde Street, Glasgow, nearly twenty years, has now set up in business on his own account as an iron merchant under the style of "Wm. Samson & Co." at 52, St. Enoch Square, Glasgow.

Messrs. John Abbott & Co. have expended £7,953 upon repairs and maintenance of plant during the year ended June 30th last. The substitution of electric for steam power is expected to prove of economic advantage to the company.

The Carlton Iron Company, Middlesbrough, have made a successful application to the committee of the Scotch Pig-iron Trade Association to have their pig-iron admitted as G.M.B. iron.

Messrs. James Jenkins & Son, 33, Renfield Street, Glasgow, have been appointed sole agents in Scotland for the Moss Bay Hematite Iron and Steel Company, Limited, Workington, and also for the Distington Hematite Iron Company, Distington, Cumberland.

Mr. Petrie has acquired from Messrs. T. C. Williams & Sons their engineering and ironfoundry business at Reading.

E. G. Herbert, Ltd., of the Cornbrook Park Works, Manchester, have acquired larger works at Rosamond Street East, Manchester.

The business of Messrs. Moorwood, Sons, & Co., Ltd., Harleston Iron Works, Sheffield, has been acquired by the Midland Manufacturing Company, Ltd., Sheffield.

Messrs. Stothert & Pitt have just constructed a powerful crane which is to find a permanent place beside the new graving dock at Southampton. The crane is one of the largest structures of its particular class. It is designed to lift a load of 50 tons, and has been worked with an overload up to 62 tons.

At the Clay Cross Coal and Iron Company's works a fire occurred recently in the pattern shop which completely gutted the place, leaving only the bare brick walls standing.

The Holwell Iron Company, Ltd., Asfordby, near Melton Mowbray, having got their new pipe and general foundries in working order, have opened a London office at 26, Victoria Street, Westminster, S.W., and are represented by Mr. H. A. Stenning, M.I.M.E.

The Patent Axle-box Company, of Saltley, have acquired some works at Wednesfield near Wolverhampton, and are at present carrying out considerable alterations and improvements there.

Messrs. Beyer, Peacock & Co., Ltd., of Manchester, have recently carried out extensive reconstruction operations at their works, and a considerable improvement has been effected in the equipment.

The Barnstaple Foundry and Engineering Works, Newport Road, Barnstaple, Devonshire, are to be offered for sale by auction on September 8th and 9th, together with all the plant and machinery, comprising a narrow gauge locomotive engine, steam boilers, pumps, lathes, machine tools, and the contents of the extensive fitting shop, foundry, smithy, carpenter and pattern shops.

William Beardmore & Co., Ltd., of the Parkhead Forge, Glasgow, have announced an issue of £500,000 4½ per cent. first mortgage debentures in five thousand debentures of £100 each, being the first part of a total authorised issue of £1,000,000 of similar debentures. This issue is to enable them to complete the establishment and equipment of the Dalmuir Shipbuilding and Engineering Works.

Messrs. Richardsons, Westgarth & Co. have arranged with the successors of Messrs. Easton & Co. to become the sole manufacturers of the latter firm's well-known specialities in general engineering, pumping, and hydraulic plant, &c. As heretofore, the designing will be conducted by Mr. P. Williams and the leading members of the old company's staff.

The Admiralty have appointed a standing committee on machinery designs. Professor A. B. W. Kennedy, LL.D., F.R.S., has been good enough to lend his services to the Admiralty, and will act as president of the committee, the other members of which will be Engineer Rear-Admiral J. A. Smith and Mr. J. T. Milton, Chief Engineer Surveyor to Lloyd's Register.

Steady progress is being made with the extensions of the works of Charles Roberts & Co., of the Railway Wagon Works, Horbury Junction, near Wakefield.

Messrs. Jessop and Appleby Brothers, Ltd., Leicester, have received an order for an electrically-driven crane from the Borough Council of Stepney, London.

The Barrow Hematite Iron and Steel Company are supplying a large quantity of steel rails to the Dundee Corporation.

Messrs. Pollock and Macnab, Limited, of Bredbury, Manchester, have received an order for machine tools for the Pietermaritzburg Corporation's car shed.

Robert Stephenson & Co., Ltd., Darlington, have secured a contract for locomotives for the Cavan and Leitrim Railway.

The Anti-Attrition Metal Company, Ltd., have taken a more extensive foundry and works at 42A, Great Suffolk Street, Southwark, S.E.

A new syndicate is making efforts to erect large blast furnaces at Nyköping, in Sweden, for the making of pig-iron. It is intended to use Gellivare iron ore and charcoal.

B. and S. Massey, of Openshaw, Manchester, had a large order for the supply of steam and pneumatic hammers to the Locomotive Department of the East Indian Railway.

John Spencer, Ltd., have completed their contract for the supply of a large quantity of different kinds of piping (mild steel gas, water and steam) to the East Indian Railway Company.

Dorman, Long & Co., Ltd., are manufacturing the following bridge girders for the Burma Railways: 2 spans of 6 ft.; 9 spans of 6½ ft.; 4 spans of 14 ft.; 2 spans of 16 ft.; and 4 spans of 20 ft.

Isaac Storey and Sons, Ltd., of the Empress Foundry, Manchester, have issued a new catalogue of their "Stella" brand alloys. Amongst these are included one of manganese copper for producing manganese bronze by the addition of zinc, also a ferro-zinc for making ferro-bronzes, and silicon copper for securing sound gun-metal castings. Phosphor-tin and copper are also supplied, as well as anti-friction metals suitable for different purposes.

THE ENGINEER IN THE FOUNDRY.*

By Dr. R. Moldenke, Watchung, N.J.

IT is not so very long ago that when an engineer had to do some detailing in which cast-iron was used, that he simply figured on a strength of 10,000 lb. per square inch, and let it go at that. To-day more is required of a man up in his profession. Where the use of cast-iron is advantageous, it makes quite a difference whether ordinary cupola metal is employed or the highest grade gun metal. In other words, the engineer should know something of the several kinds of cast-iron made, how they are made, and how used to the best advantage.

The best indication of this modern tendency is seen in the recent presentation of specifications for testing cast-iron and finished castings. These arose from the demand of the buyer to know what he is paying for, and as a consequence he is learning to specify his wants more clearly. Then also there is the desire of the engineer to acquaint himself with a material he is called upon to inspect for the buyer, and pass upon as good for the purpose or not. Finally the foundryman himself, in his most broad-minded form, has always been desirous of giving the customer the best he can make, and indeed must do this, or find his product replaced by the malleable or steel casting. All these tendencies have brought about a general getting together of those most interested, with the result that for the first time in the history of the iron industry has a common ground been found for working specifications governing the testing of cast-iron and its products. We will, therefore, look into this subject more closely, and see how the engineer can utilise his knowledge of metallurgy in dealing with the foundry.

For the purpose of the engineer we can divide the general subject cast-iron into the following heads: The metal without subsequent extended annealing, or all classes of cast-iron proper; and with subsequent extended anneal or malleable cast-iron. I say extended anneal to distinguish the removal of the casting strains simply in any kind of casting by the application of moderate heat for a short time only, from the long annealing given a special class of white iron which is unfit for use in its condition as it leaves the moulding floor, but becomes tough and malleable as well as just short of steel in strength after the heat treatment has been applied.

Cast-iron may be further divided into the grey varieties, and the chilling irons. The grey varieties may again for our purpose be divided into the ordinary jobbing castings such as for buildings; the machinery irons, light, medium, and heavy; the special irons made in the furnace, which run up to 35,000 lb. per square inch and over; and finally the softer irons, such as would find their best application in ornamental work. Stoves, art castings, novelty work, etc., would come in here. There are some sub-classes to be considered here, such as iron for pipe cylinders, refractory metals for grate bars, and the stuff only good for sash weights and floor plates.

In the chilling irons we find first the car wheel iron, which is both soft and hard, depending upon the mould it has been cast into; the roll irons; and special work, such as for crusher jaws, grinding mills, and the wearing parts of machinery.

It will be easily seen how the civil engineer will be specially interested in cast-iron going into railroad and bridge construction, whether for actual working

*Read at the Indianapolis Meeting (June, 1904) of the American Foundrymen's Association.

parts, or merely the ornamental end. Similarly in the designs of buildings, whether terminals or sky-scrapers. The mechanical engineer naturally has more to do with cast-iron, and runs through the whole gamut in his daily practice. In the railroad service he deals with malleable as well as grey iron castings in his car construction. The locomotive adds some steel castings to these. Then the cast-iron car wheel will give him enough to think of, as will be seen from the specifications alone. In the machine shop, rolling mill, and in the foundry itself, the mechanical engineer should be a master in adapting this metal, in its various forms, to the purpose in hand, and hence he cannot learn too much of the production of all classes of castings, grey, chilled, malleable, and steel.

Finally, the mining engineer, who has probably to suffer most from breakdowns with iron castings, as he is always isolated and must transport his repair parts great distances. He also should know something of foundry practice, as he could oftentimes help himself by "burning on" a broken piece, if he but knew how to rig up a temporary cupola out of an old boiler shell, and drive compressed air into the charge.

Some distance across the border down in Mexico I saw a foundry which made it a business to cast repair parts for the various mines tributary to the city wherein it is located. This foundry used but little pig-iron and much scrap, the scrap being inferior and the pig-iron worse; the result is not to be wondered at, and hence it is the custom to send a duplicate order to the States for the same piece, which usually arrives just when the Mexican casting breaks. Had some of our young engineers in such regions knowledge of foundry metallurgy, they could take charge of the foundry for the time being and get creditable results, and the double expense and vexation would be avoided.

Taking up first the pig-irons, in the light of the specifications governing their purchase, we note that the charcoal irons form a special class by themselves. The cold or moderately warm blast used, together with the more perfect reduction of the ore, produces an extremely sound and strong metal which cannot be always duplicated in the hot blast coke process. This iron, therefore, goes into the highest grades of castings, and cannot well be covered by ordinary commercial specifications governing the great bulk of the pig-iron made. Similarly the high silicon irons and the ferro-silicons are a class by themselves. Being used only in very limited quantities, their impurities are not so important, so long as there is a great preponderance of silicon for mixing purposes.

Two cardinal requirements are laid down in specifying for pig-irons: The content of silicon and of sulphur for the grade numbers known to commerce. These are as follows:—

Grade.	Silicon.	Sulphur.
No. 1	2.75 per cent.	0.035 per cent.
No. 2	2.25 „	0.045 „
No. 3	1.75 „	0.055 „
No. 4	1.25 „	0.065 „

A clause is added to the specifications intended to take up the personal equation in sampling and in the analysis of the sample, a leeway of 10 per cent. being allowed in the silicon and 0.01 in the sulphur that may be above the table. This variation may be doubled before the iron can be rejected, but a penalty is provided, thus reducing the cost to the buyer. While this penalty is small, yet it is only fair to the furnace man who has so many kinds of iron to pile up and care for, while the foundryman can always help himself with the iron he receives by judicious mixing. The better posted the foundryman is, the more liberal he will be with his pig-iron dealers. Personally, I have never rejected a car load of iron in my life of the several hundred thousand that have passed through my

hands, but once in a while there have been heart to heart talks with the agents, resulting in concessions in price, and the iron was suitably mixed up and used. With these specifications and the assistance of a commercial laboratory, even the most back-number foundryman can get suitable iron for his castings, without relying upon the uncertain fracture appearance of a freshly broken pig, as he has done heretofore.

Perhaps the most important of the specifications, from the standpoint of the engineer, is that for testing cast-iron as a metal. This is the result of years of thought and experiment by engineers' and foundrymen's associations, as well as independent investigators, thoroughly digested by those who were most active in this work, and the result approved by a majority of the cast-iron experts of the country. The following principles were recognised. In America we prefer to judge a casting which cannot be tested to destruction by the quality of the iron entering into it. That is to say, by pouring the melted iron into test bars, under standard conditions, and then testing these bars to form conclusions therefrom. Next it is recognised that these bars should be made of as large a section as possible, consistent with a proper structure, or constitution of the iron, to avoid the artificial influence of damp moulding sand, variations in pouring temperature, cooling strains, &c. Also to keep the tests within the limits of the ordinary testing machines found in our foundries.

Then comes the cross-section of the bars, the round form being better than the rectangular, as it avoids the artificial cooling at the corners. Next the manner of casting. Experience has shown that a bar cast flat, when tested in the position as cast, gives different results from those obtained when the bar is reversed. Hence the importance of casting the bars vertical. The refinement of the bottom pour, though giving better results, is too cumbersome for commercial use. A suitable rotation in the casting of these bars is necessary, so that the results may be representative. The bars are not to be tumbled, as this would remove casting strains, and make the material artificially strong when compared with the castings themselves, which are not so treated. Finally comes the testing of the bars themselves, which experience has shown to be the best accomplished by placing them upon supports 12 in. apart, and breaking by applying the load at the centre. The deflection is also noted.

The best way to test castings is to take, say, three out of a batch of 103, all being made from the same heat and under the same conditions, and actually breaking them under as nearly service conditions as may be. For instance, the car wheel is now so tested in practice, not only by using the drop weight on it until shattered, thus giving the extreme of the pounding it would get in service, but by pouring around the chilled rim a stream of melted iron, and noting the effect. Here again the extreme effect of the brake is applied to the wheel. If the three wheels thus treated will come up to expectations, the other hundred are accepted. Thus it will be seen how carefully material is looked over where life and property hang in the balance. In making boiler castings, every one of them should be subjected to the hydraulic test, and put under pressures at least two and a half times as great as the one to be kept up in actual service. If, on going over the castings carefully during the test, they stand up all right, they may be regarded as safe. Similarly a number of classes of other castings are tested under actual service conditions with very good results.

The great bulk of castings, however, do not lend themselves to such tests, and hence it is necessary to pour bars to judge the iron as poured. The art of the

founder should then insure the quality of the castings made to be as nearly that of the test bars. This, of course, is not always the case, but the buyer soon learns where he can get the best work suited to his requirements, and hence the incentive on the part of the founder to do the best possible for him. With a good iron as shown by the test bar, it is possible to make bad castings, but with a bad iron as shown by the test bar, it is not possible to get good castings. Hence our American method of giving the test bar the best chance possible, in order that one gets a correct idea of the situation, and can size up the founder's ability to do good work, or his judgment in buying good or bad irons. There is nothing better than to have the foundry laboratory open to the free use of the inspector, so that he can see the shop tests before him all the time, whether for his work, or that of the general run. This creates confidence, and invites suggestions for betterment all around.

One of the things the engineer should know is when and where to use cast-iron. I have always felt that this material has no business in structures where life may be endangered in case of accident, other than in the ornamental portions. The cast-iron bridge member is now, fortunately, a relic of the olden times, and gradually cast-iron has been replaced by steel where lightness and strength is an object. These tendencies can, of course, be carried too far, for there is no economy in using expensive steel construction in places where cast-iron will do just as well. Wherever there is a quiescent load which requires a material with high crushing strength to sustain it, there cast-iron will be found most valuable. Wherever art work is to be added to the cold and bare constructions of the engineer, there cast-iron is essential. The fact that last year some 3,600,000 tons of castings were made here shows what this industry means to our country.

I therefore commend the foundry to the engineer's most earnest attention, as he can hardly turn about in his professional work without coming into contact with its products. With the excellent literature now available in this branch of the arts, with a progressive technical Press, and the welcome he will get in visiting foundries, there is no reason why an engineer should not be well posted on cast-iron, and thus make experience serve him all the better in the daily problems of his profession.

PIG-IRON AND ITS ELEMENTS.*

By H. L. Williams, Chicago.

WE find pig-iron and castings made up in the main of metallic iron, carbon, silicon, sulphur, phosphorus, and manganese, the other elements, such as titanium, copper, arsenic, &c., seldom being important enough to cause trouble.

Metallic iron runs 92 to 94 per cent. in our foundry and mill irons. It is the same whether in pig-iron, steel, wrought-iron, castings, &c. Were it alone to be considered we need not worry about grading by fracture or analysis. We must look for the differences that occur in the various classes of irons in the additional elements present. To control these foreign elements is the task of the founder.

Carbon is most important in cast-iron. Its effect on iron is positive and varied. Free carbon, or graphite, may be either in the pig-iron between the crystals, or if in considerable excess, leave the iron at the moment of set, and fly off as "kish." Combined carbon, or the carbon which remains in combination with the iron, is the hardening substance in iron,

*Read at the Indianapolis meeting (June, 1904) of the American Foundrymen's Association.

and when all the carbon is present in that state, leaves it perfectly white. This is turned to practical account in making chilled castings, the effect of a sudden cooling of iron by throwing into water, or casting against a heavy body of cold iron, promoting the retention of the carbon in the combined state. In this way car wheels, crusher work, rolls, and the like are made, with iron otherwise grey if left to cool slowly. If a casting is too hard a correction must be sought in freeing more of the carbon and getting it into the graphite state in subsequent castings. Hence softness and hardness of iron in foundry work are chiefly controlled by carbon.

Silicon in iron frees the carbon, depending upon the amount present, the shape and weight of the casting, and the pouring temperature. In other words the rate of cooling. If the iron is high in combined carbon and hard, add silicon to soften it. It will do this unless prevented by too much sulphur, phosphorus, or manganese. If the iron is too soft, reduce the silicon. If the iron is too hard, and low in total carbon, too much silicon is not good, as it is only effective through its action on carbon.

More silicon is required in thin castings than in heavy ones, as the latter cool slower, and give the carbon time to separate out, while the former cooling quickly chill more, and keep the carbon in combination.

Manganese increases the affinity of iron for carbon. In heavy castings it is well to have 0·80 per cent, and in light work only 0·50. With these proportions the metal will be clean and strong. Below 0·50 the metal is inclined to sponginess, and above 0·80 there is a chance for hard iron. Manganese also reduces the sulphur present. In chilling work, high manganese gives a strong, hard, sharp chill. It can be used up to 3 per cent. in such mixtures. Phosphorus increases fluidity, corrects shrinkage, and is desirable in the foundry up to 0·50 for ordinary foundry castings, and up to 1·25 for ornamental products. Phosphorus hardens iron, and very much of it requires plenty of silicon to neutralise the effect. Excessive phosphorus with low silicon makes bad foundry work.

Sulphur combines carbon, erratically causing hardness, closing the grain, and weakening the castings. In ordinary castings it should not exceed 0·09, but may go above this in common work requiring no machining. It is the great enemy of iron, and should be kept out as much as possible. The fuel is a fruitful source of sulphur, hence this should be watched.

It will be noticed that silicon opens the grain of iron by freeing the carbon, while all the other elements close it by retaining the carbon in combination. In these effects we find the relation of grading by fracture and chemical analysis.

SCOTTISH NOTES.

(By Our Own Correspondent.)

NEITHER with regard to the volume of business nor the prices obtained for manufactured goods, can the slightest improvement be chronicled in the Scottish ironfoundry trade. Trade has been, perhaps, even more dull before, but never has it been so difficult to obtain paying prices for ironfoundry manufactures. The immediate future does not indicate any improvement. In such a depressed market, when new work is so difficult to get, and when there are so many firms after it, there is not likely to be any advance in the prices obtained by manufacturers for ironfoundry goods. The firm that can sell the cheapest, although not necessarily the best article, is the firm that is booking the most orders.

The dulness in the ironfounding trade of the country, which has been so

prolonged and so pronounced, is chiefly attributable to the fact that there is, both in Scotland and in England, too many foundries. In Scotland, and in the Falkirk district particularly, there have in recent years been an enormous number of new starts, and when they all get a share of what work is going, there is only a little for each. Price cutting is the result of the keenness in competition for the trade that is to be had. Not till business is twice better than it now is will there be any prospect of manufacturers getting anything like the old rates. When trade is brisk there will be little disposition for firms to indiscriminately undersell each other.

Within the last month there has been no marked improvement in the light castings trade in Falkirk district. Out of thirty-four foundries in the district, twenty are working only five days per week. Castlelaurie Foundry (Falkirk Iron Company's) although still working five days, is now busier than it has recently been. For some time past workmen in this foundry have been making telegraph posts for the Government, on which some forty or fifty moulders are employed. In June the orders on hand for these posts were exhausted, and the men were thrown idle. Now, however, a substantial order has been secured for the same class of work, which will, it is expected, keep the men working for some months. Since the depression in trade began the Camelon district of Falkirk has always kept the busiest, fewer men being returned as out of work to the agent of the Central Ironmoulders' Association from that district than from any other.

The August report of the Associated Ironmoulders of Scotland, which has just come to hand, shows that the total membership is 7,234, with 238 apprentices. Both of these figures show a slight decrease on the last month. The working members are returned at 5,486, which is 27 more in employment than returned last month. This month 1,053 moulders are returned as unemployed, which shows how bad is the trade.

Mr. James M. Jack, the general secretary of the above association, in his monthly report says:—"We had expected better trade with the beginning of the lengthening day, but such has not come as desired; and we must continue to hope even yet that the autumn days may make up for the non-realisation of better times with the advent of summer."

In the sixty-first quarterly report of the Central Ironmoulders of Scotland, Mr. Hugh Murdoch, Falkirk, general secretary, states that the membership stands at 3,781. The income for the quarter amounted to £1,027 14*s.* 5½*d.*, and the expenditure to £174 5*s.* 9½*d.*; the sum of £853 8*s.* 8*d.* has been added to the bank account, which now totals £27,669 8*s.* 5½*d.* The association, it is stated, have resolved to become affiliated with either the General Federation of Trades Unions, London, or the National and International Federation of Trades Unions, Bolton, and the schemes of these organisations have to be submitted to the members with the object of enabling them to decide which one of the two they will adopt. The ballot vote recently in connection with the election of three representatives to the Executive Council has resulted as follows:—Arch. Logan, 868; James Moore, 863; R. Anderson, 859; and J. D. Silcock, 692. The new member is Mr. Moore, who succeeds Mr. Silcock.

Fire in a Local Foundry.—Shortly after five o'clock on the morning of Friday, July 29th, David Spears, signalman at East Carmuirs Junction, observed that fire had broken out in the moulding shop at the Scottish Central Ironworks. He at once hurried to the scene, and threw several pails of water on the fire. He had, however, to return to the cabin to shift the signals, and, thinking that the fire would have secured too firm a hold before he got back, telephoned to Falkirk for the fire brigade. He then returned to the scene of the fire, and succeeded in getting

the outbreak extinguished before the arrival of the fire brigade. The damage, which is estimated at £50, is covered by insurance. The origin of the fire is unknown, but it is supposed to have been caused by the placing of two moulding boards against the wall, these having been in use just before the men stopped work, and in these boards are a number of crevices, where fire could have smouldered for a considerable time before it broke out.

The *Aberdeen Free Press* records the death on Friday, July 29th, of Mr. Charles Mitchell, grate manufacturer, Aberdeen, at the advanced age of seventy-nine years. The deceased gentleman was a native of Falkirk, and was an apprentice under the late Mr. James Thomson (father of Mr. A. F. Thomson, chairman of the Falkirk Parish Council), as a grate-fitter in Falkirk Iron Works. Leaving Falkirk, he went to Glasgow, but again returned to his native town to fill the position of foreman grate-fitter with the late Mr. R. W. Crosthwaite, of the Union Foundry, Port Downie. Being desirous, however, of improving his position, he again left Falkirk about fifty years ago, this time for Aberdeen, where he commenced business on his own account as a blacksmith and grate manufacturer. In the Granite City, all who had business connections with him, recognised in him a most worthy man, capable and trustworthy in his own line of business, to which he paid the closest attention. He had quite a reputation in regard to the excellence of his workmanship, the grates and kitchen ranges turned out by him being marked by a substantiality and finish which made for them an enviable name in the market.

Mr. Mitchell, who was a man of a kindly manner, and marked uprightness and independence of character, had not, however, in consequence of advancing years, taken any active part in business for some time. As has already been stated, he was a native of Falkirk, and he frequently boasted of being able to say that he was born in the room in which "Bonnie Prince Charlie" slept during his visit to Falkirk. He was fond of telling about his young days and his associates in Falkirk, with which town he has kept up a trade connection since ever he left, by obtaining the castings for grates from several of the local foundries. His father, it may further be mentioned, was for some time precentor in the Relief Church in the early days of the late Mr. Welsh's ministry, and his grandfather ("old Charlie," as he used to be called), was the smith at the "Thorn" Smithy, an institution of the past. The late Mr. Mitchell is survived by Mrs. Mitchell and a family of three sons and two daughters, the sons carrying on the business which the father had built up in the course of his long and active life in Aberdeen.

The annual excursion of the Associated Ironmoulders' (Paisley district) super. members annual excursion, which is subscribed for by the working members of the district for the benefit of their aged brothers and their wives took place on Saturday, July 29th. The party left Paisley about 10.30, and proceeded by train to Prince's Pier, where they got the steamer to Dunoon. Here refreshments were served by Mr. M'Crossan (late of Paisley). After an hour's pleasure the company dined at the restaurant of Mr. Barr, who supplied a splendid dinner, which was thoroughly enjoyed by everyone. A machine then took the party a drive to Loch Eck. During this trip the driver stopped several times to allow them to have a fuller view of the surrounding country, which, in the splendid weather, was looking its best, and each one seemed to realise that for beauty old Scotia is second to none. After a few hours spent in admiring Loch Eck, the company drove back to Dunoon, when Mr. Barr again provided for the inner man in a most gratifying manner. After tea and a rest, a move was made for the steamer and home. On arriving in Paisley, a special half-hour was spent together, when

Messrs. Begg and Hogg were warmly thanked for their work in looking after the arrangements for the enjoyment of their older brethren. The company then broke up, and all made for home, having enjoyed themselves thoroughly, and feeling much better for their day's outing.

SHEFFIELD NOTES.

THE general state of trade in this district shows no signs of improvement with the opening of the second half of the year. Almost every branch seems to be dragging on in a disheartening manner, and every possible device that is put forward to try and improve matters meets with very little success. In a few isolated cases there are reports of new work coming forward more freely, but they are very exceptional. The outlook generally rather tends to show a further decline.

The ordinary crucible steel trade seems to be the greatest sufferer; the turnover in this department is estimated at less than one-third the amount that was manufactured but four years ago. Experiments are being made by a few crucible steel makers for the production of aluminium steel for commercial purposes; up to the present nothing definite can be stated, but one firm in particular is undergoing some very exhaustive experiments to this end and are exceedingly sanguine as to the result.

The demand for armour-plates, heavy forgings, &c., is very unsatisfactory, and unless fresh orders soon arrive most of these departments will have to be set down, as the work on hand is chiefly in the finishing stages.

The foundry trade of the district, both iron and steel, remains practically unchanged. Messrs. Moorwood, Sons, & Co., Harleston Ironworks, have just completed an order for a 50-ton ingot mould for a Darlington firm. The latest quotations of prices in Sheffield are: Lincolnshire forge-iron 44*s.*; Lincolnshire foundry-iron 45*s.* 6*d.*; Derbyshire forge-iron 43*s.*; Derbyshire foundry-iron 47*s.*; East Coast hematites 57*s.* 6*d.*; West Coast hematites 63*s.*; Bessemer billets £6 5*s.* to £6 10*s.*; Siemens-Martin £7 to £7 5*s.*

We understand that Mr. R. A. Hadfield, of the Hadfield Steel Foundry (Hecla and East Hecla Works, Sheffield), is to be the next president of the Iron and Steel Institute, in succession to Mr. Carnegie. Mr. Hadfield has taken an active and prominent part, not only in the interest of the Institute, but the whole iron and steel world, judging simply by his essays in connection with manganese, tungsten, &c. It might be stated that Mr. Hadfield was the first to institute the eight-hour system in connection with foundry practice in Sheffield. He is also the head of the largest foundry in the world.

MIDLAND NOTES.

THE trade in all sections shows a decline upon the previous month, and at the majority of foundries a full week's holiday at the beginning of the month was observed. The prices obtainable are at a low ebb, but during the last few days there was a tendency for betterment.

Mr. Joseph Evans, senior partner in Messrs. Joseph Evans & Sons, Culwell Foundry, Heath Town, has been called to give evidence before the Tariff Commission in the engineering and machinery section.

An invention has been patented by Messrs. B. Parkes & Sons, Ltd., and J. Parkes, ironfounders of Dudley, that relates to curbs.

According to the *New Lady's Magazine*, published in the closing part of the 18th century, it appears that the discovery of enamelling various articles for ordinary use and ornament was made by a native of Wolverhampton named Neal, who was

at that time better known as "Old Green Hair." This appellation doubtless was invented owing to the discolouration of his hair, brought about in the course of employment. It is claimed that Neal was a snuff-box maker, and it was by accidentally dropping a snuff-box—presumably made of brass—into a basin of water that he made his discovery.

When an ironfounder named George Gwinnett, of Spout Lane, Walsall, came up at the local bankruptcy court, he attributed his failure to bad trade. He said he commenced business with a capital of £130, and it never paid. There was now a deficiency of £103 10*s.* 5*d.*

For witholding £12 7*s.* 3*d.*, money belonging to the National Federation of Blast Furnacemen, William McTighe (40), Temple Street, Bilston, was fined 20*s.* and costs. The society did not press the case as the money would be refunded. McTighe said he had had a few words with his wife, and went off in a passion, not having any intention of taking the money.

The enamellers engaged by Messrs. T. & C. Clarke, ironfounders, Wolverhampton, were, through the generosity of the chief chemist (Mr. H. G. Powell), taken into the country for a day's outing. Weston, the seat of Lord Bradford, was the rendezvous, and a very enjoyable time was spent.

One of the best-known ironfounders and engineers in the Black Country was Mr. Isaac Alfred Thompson (63), of Wolverhampton, and the news of his death by drowning caused a great sensation. The deceased gentleman, who for some years was partner in the firm of R. & T. A. Thompson, ironfounders, of Bilston, went with his son on a holiday tour in Wales. Whilst the two were bathing in the sea at Towyn, the father was seized with cramp, and sank before aid could reach him. At the time of his death Mr. Thompson was a traveller in the employ of Messrs. Charles Akrill & Co., engineers, West Bromwich. At one time he took an active interest in public affairs, he serving as a chairman of the Bilston Township Board of Commissioners, a body that has been replaced by the Urban District Council. Mr. Thompson was also closely identified with politics, he being a past president of the local Liberal association.

Since our last issue there have been several important actions tried at various courts in the Midlands that have special bearings upon the ironfoundry trade. At West Bromwich, Messrs. Josiah Guest & Son, ironfounders, Ryder Street, Great Bridge, were the defendants in a case under the Employers Liability Act, 1880. The action was a claim of £214 10*s.* 0*d.* damages said to have been sustained by an employee named Ernest Saunders (18), living at Croft Street, West Bromwich. It was contended by the plaintiff that on March 23rd last, whilst unloading a trolley of a number of "chills" or iron moulds, the top chill slipped and crushed his leg against the back of the trolley and he sustained such injuries that necessitated amputation from the knee. During the hearing of the case, it transpired that the insurance company had induced the mother of the plaintiff to sign an agreement accepting compensation but it was shown that this had been done without the consent of the plaintiff and was not binding. The defence was that there was no negligence on the part of the defendants, and that the plant was perfect. The jury found for the plaintiff for the full amount claimed, but as mention of appeal was made, the judge granted stay of execution on the condition plaintiff was paid 13*s.* 9*d.* per week in the meantime. Another case tried at Walsall was one which Messrs. Kirkpatrick & Co., ironfounders, Wedenek Street, Walsall applied to his Honour Judge Roberts, for the termination of an agreement made with Joseph Daniel Evans, carter, living at Countess Street, by which the latter was entitled to 10*s.* per week, under the Workmen's Compensation Act. Mr. E. W.

Cave, barrister of the Oxford circuit, made the application.

The particulars were that on last February 22nd, Evans was run over by a horse, and had his thigh broken. The firm recognised his total incapacity and paid him the compensation up to July 2nd. It was claimed that in a normal case, Evans would have been able to resume work by that time, as by the end of May he had recovered so far as to get about with the aid of a stick, but it was alleged that on June 11th, Evans returning home after having been to a public-house trod apparently upon a piece of orange-peel, and fell with the result that his thigh bone was again broken, but in a different place.

Thus, Mr. Cave urged, was proof that the original injury had perfectly healed, and that the second accident was in no way connected with the original injury, the employers consequently being in no way liable for the respondent's present incapacity. Two doctors were called to speak as to the condition of Evans, and both agreed that some time after the removal of the splints the man's leg would be very stiff, and that his condition would be one of partial disablement, in which he would be less able to save himself from falling when the second accident happened. The judge commented upon the fact that the respondent had not given evidence. The medical evidence he said was merely theoretical. He held that in this case there had been a new act which broke the chain of causation and he reduced the award to 1*d.* per week from July 12th, last, but in view of the nicety of the point raised, there would be no order as to costs.

The students attending the Staffordshire County Council metallurgical classes in Wednesbury Science School have gained twenty-three honours distinctions at the recent examinations in "iron and steel manufacture" and in "metallurgy." The Wednesbury class—which is under the immediate supervision of Mr. Walter Macfarlane, F.I.C.—has held the premier position in the kingdom for the past few years.

NOTES.

The Great Central Railway have acquired five more "Atlantic" type engines. They have been built by Beyer, Peacock & Co., of Gorton, in record time, having been commenced in the first week May.

Mr. T. Matthias, who has for the last twenty-five years been with Messrs. Williams & Michell, iron and metal merchants and brokers, of 4, Bath Lane, Swanage, has now purchased the business, and will carry it on under the old style.

The Rhymney Railway Company has just added three large locomotives to its stock. They are made by Sharp, Stewart and Company, and are of a heavy class, well adapted to meet the urgency for dealing with longer mineral trains.

It is stated that a convention providing for the construction by the Federated Malay States of a railway through Johore, in continuation of the main trunk line through those States, was signed on August 15th.

J. & J. Hughes, Ltd., have supplied a large quantity of gun-metal to the Assam-Bengal Railway Company for foundry purposes. The company's workshops are still in their infancy, but being an isolated railway they must soon develop into a self-dependent position.

The death is announced of Major Todd, aged seventy-nine years, who was manager of the foundry department of the Birtley Iron Company, Limited; also of Mr. Arthur Bainbridge, a well-known iron merchant, of Stockton, who did a large business in the breaking up of old works. He was chairman of the Stockton Higher Grade School during the lifetime of the School Board, and since has been vice-chairman of the Education Committee of the Stockton Corporation.

The managing director of the Midland Ironworks, at Donnington, near Wellington, has returned from Canada, where he received an order for a large steel tank—134 ft. diameter and 33 ft. deep—and for a telescopic gas-holder of four lifts. The total amount of the contract will be close upon £30,000. Competition with American firms was very keen, and were it not that preferential tariffs in favour of England are now in force in Canada in connection with all constructural iron and steel work imported, the ord er would probably not have been secured by England.

The Donegal Railway Company have placed a contract with R. Y. Pickering and Company (Ltd.), Wishaw, for new carriages, cattle trucks, and carriage trucks (the first item comprising composite lavatory carriages, third-class saloons, and third-class and brake carriages). The covered and open goods waggons have been ordered from the Metropolitan Amalgamated Company, of Oldbury. It is interesting to note that Pickering and Company are at present shipping from Hull the wheels and axles they are making for the Indian State Railways. This is due, we understand, to the fact that the rate of freight from Hull to Karachi is very considerably less than the rate from Glasgow to Karachi.

A new process for hardening iron has been developed by two Prussian inventors. It consists in adding to iron a small percentage of phosphorus combined with a large amount of carbon. The iron is heated in a tempering powder consisting of bone dust, to which are added 300 grains yellow prussiate, 250 grains cyanide of potassium, and 400 grains of phosphorus. The receptacle is closed and luted with clay, and raised to a clear red or white heat. The material treated is then taken out and plunged, while still hot, into a warm bath. It is claimed that this will harden the surface of a piece of iron weighing 400 lbs. to a depth of about 0·04 in., and that the iron can neither be cut nor chipped by the best steel used, and that it can be readily welded.

The Anderston Foundry Company, Limited, are under orders to supply by July, 1904, sixty sets of steel crossings of different angles, and the same number of switches (with different lengths of tongue), to the Bengal-Nagpur Railway. They also have a large order for the supply of points and crossings to the Assam-Bengal Railway.

QUERIES.

This department of the JOURNAL *undertakes the answering of queries in the following branches:* Blast Furnace Practice, Basic (steel making) Processes, Cast-iron, Malleable Cast-iron, Steel, Brass, Bronze, &c., *by eminent authorities in each branch. When necessary, the aid of chemical analyses, mechanical testings, micrographic, or microscopic examinations will be invoked.*

The queries will appear repeatedly till answered. No charge is made to readers for answers, except where chemical, mechanical, or micrographic analyses are necessary, in which case the actual fee paid by us will be charged.

There are many other queries outside the scope above referred to which reach us at various times which we trust our readers will afford us assistance in answering.

Communications should be addressed to the "Editor, THE FOUNDRY TRADE JOURNAL, 104. Great Russell Street, London, W.C.," *and marked outside* "QUERIES," *and must be accompanied by the correct name and address of the querist, not for publication, but as a guarantee of good faith, which will be treated, with strict confidence.*

Bricks.—What kind of bricks are the best for lining a foundry cupola and where made. YORKSHIRE SUBSCRIBER.

Loam.—I should be much obliged if any of your numerous readers will kindly give their experience, as to the average quantity of loam required for use in an

iron foundry turning out about 140 to 150 tons of fairly light castings per week. It would be interesting to know the average quantity of loam bought for each ton of iron casting.—Yours truly,

NORTHERN SUBSCRIBER.

Plates for Enamelling.—I wish one of your great many readers would please explain an item of interest to me. We at present are making a great many plates for enamelling, we do not see any fault with the plates as they pass through the examining shop, and we look at them very carefully, nevertheless we have a good few come back from the enamelling shop with small holes in them about $\frac{1}{16}$ deep, and about the size of a small pin's head. Would some one please inform me the reason that the enamel will not fill up these small holes, or how we can stop them as moulders. One anxious to learn.

BLACK SAND.

Blackings.—Will any of your numerous readers kindly give their experience with regard to blackings.

We are having some trouble in our foundry in this respect. Our castings do not come out at all clean; sometimes we have to chip the facing off, then the casting has the appearance of having been moulded in loam without any blacking on. We shall be indebted to your valuable journal and to any practical foundryman who will kindly give us a hint in this direction.—I remain, yours truly,

LOAM-MOULDER.

Brass Liner. — Being an interested party in this job, and as failure to get a good casting occurred two or three times, I have thought, by bringing it before your readers, there might be information forthcoming for all concerned in this class of work.

Not being a brass moulder myself, I can only deal with the surface of things, and hope for a bit of give and take from all who may feel inclined to do so, and from what has been already given by your practical readers, I think your journal has improved by throwing its pages open for the discussion of practical questions such as "bad castings" or anything that is of interest in either shop or Foundry connected with the trade.

The casting in question when polished was more or less speckled with small black holes, say, in size from a pin point to about three-sixteenths of an inch, and of irregular dimensions which became aggravated by grouping themselves in several places from top to bottom in zig-zag fashion—this, of course, condemned the casting.

Some blamed it on the mixture of metal, others blamed it on the coke, and, as might be expected, the core and cope had their share of attention also.

All agreed that it was dirt, but as to where it came from remains as yet a puzzle.

If any of your readers would give us their opinion so as to assist us in future I shall feel obliged, and thus enable us to produce our work as near as possible with a first cast in this the age of keen competition. Wishing the journal the success it so richly deserves, I enclose my card and remain, yours very truly,

March 30th, 1904. SUBSCRIBER.

I think "Subscriber's" trouble is in casting of the mould. The bad places are the scum that rises on the top of the metal when pouring, the zig-zag places are proof of this; when pouring slow with dull metal a scum forms on the top of the metal which clings to the core or the mould and causes the zig-zag places. I had the same trouble when I first made liners. If "Subscriber" will see that metal is hot, and a good runner to take the metal sharp and run from the top, I think "Subscriber's" trouble will be over.

BRASS MOULDER.

Cupola Charges.—I have read a great deal in your paper about successful working of cupolas. I have been trying for some time to get the best results of ratio of iron to fuel for light castings; at the present time we are melting 10 ton × 8 cwt. to 10 ton × 12 cwt. per day to 17 cwt. of coke, ratio about 12 × 1, I believe; of course, this includes bed as well, which is 6½ cwt. I should be glad to know of anyone who has had better results.

FOREMAN MOULDER.

I would like to ask "Foreman Moulder" the size of cupola, and if the scrap is heavy or light would he kindly say the weight of the heaviest piece he can melt, and how long does it take to melt 9 tons 10 cwts.

The class of work I have to deal with is small cylinders ranging from 2 cwts. to 12 cwts., liners, and engine work, to machine bright all over. I am melting 9 tons per day, and the best I can do to get good castings is 2¼ cwts. of coke to ton of iron counting the bed in.

DOUBLE TUYERES.

The London County Council has placed the order for the whole of the cast-iron segments for the construction of a sewer in Victoria Street, Westminster, with the Holwell Iron Company, Limited, Asfordby, near Melton Mowbray.

The Holwell Iron Co., Limited, of Ashfordby, Melton Mowbray, has been successful in obtaining the contract for supplying the Leicester Corporation Water Works with all the cast-iron pipes required for the high-pressure mains during the ensuing year.

C. & A. Musker (1901), Ltd., have received the order from the Seaham Harbour and Dock Company, through Mr. P. Walter Meik, for the supply and erection of the hydraulic installation at Seaham Harbour, consisting of hydraulic accumulator, gate machines, sluice machines, capstans, pressure mains, valves, &c.

METAL MARKET REPORT.

LONDON, July 30th.

TIN.—This metal has had a stronger market. Good sales to America and China and firm advices from the East have enhanced values. Closing on the 1st at £118 5*s.* it dropped to £117 on the 6th and 7th, rising thence to £123 15*s.* on the 22nd, and closing on the 29th at £123 5*s.*

* * *

Copper has been in steady demand, and with a firmer market prices have advanced, closing on the 1st at £56 17*s.* 6*d.*, and on the 29th at £57 5*s.*

* * *

Spelter.—There has been more buying of this metal, and prices have hardened. Closing price on the 1st, £22; on the 29th, £22 5*s.*

* * *

Lead.—The demand for English lead has been better, with the result that prices have increased. On the 1st £11 15*s.*; on the 29th, £12.

* * *

PIG-IRON.—There is little in the way of improvement to report about this metal. Cleveland foundry iron is still scarce in the makers' hands. Although the position improved around the 12th of the month, there was a quick return to the dulness and depression of the previous month. Makers, however, maintained a strong and independent position, and were able to force prices up, closing at 42*s.* 4*d.* on the 1st, it realised 42*s.* 10½*d.* on the 29th. In Glasgow things have been worse, foundries are badly off for orders, and what with preparing for the holding of the Glasgow fair, holidays, and the moderate start since, the trade has been dull indeed.

* * *

Hematite.—The position of makers of this iron is worse than ever, there is a slack demand, buyers are only ordering for their immediate requirements, and competition is very keen for the few orders there are about. Prices have slackened, quotations being for East Coast 51*s.* 3*d.*; for West Coast 54*s.*; mixed numbers f.o.b. usual ports.

PUBLIC STORES STOCKS OF PIG-IRON IN TONS AT LATEST DATE AVAILABLE:

	Aug. 11, 1904.	Aug. 13, 1903.	Decrease.
Connal's at Glasgow	9,560	13,243	3,683
Connal's at Middlesbrough ...	79,000	133,574	54,574
Connal's at Middlesbrough hematite ...	300	300	...
West Coast hematite	15,270	18,156	2,886
Totals ...	104,130	165,273	Net dec. 61,143

* * *

PRICES OF WHOLESALE COMMODITIES. APPROXIMATE prices and position at latest date for which statistics are available, with prices and quantities at the corresponding dates in each of the last two years:—

METALS.	1904.	1903.	1902.
Iron—Scotch pig warrant ton	.....52/3 nom.	.....51/6	..... 56/4½
—Middlesbro' warrants ton	..... 43/7	..... 46/10	..... 51/5½
—W.C. M/nos Bessemer ton	..... 53/6	.....58/0	.....61/0
—Staffordshire bars, Lond. ... ton	£6 10—£8 10	.....£7—£7 5	.....£8—£8 5
—Welsh bars, Wales... ton	... £6—£6 5	... £6—£6 5	.....£6—£6 5
—Stock, Scotch, Aug. 12 tons	 9,560	13,243	43,202
Copper—Chili bars, GMB ton	56 10/-56 11/3	£58 5—58 6/3	51 10—51 12/6
—Stock, Europe and afloat... tons	12,867	14,949	21,313
Tin—English ingots ... ton	£124-£124 10	£128 15-£129	£125—125 10
—Straits ton	121 17/6—122	127 15-127 17/6	124 10-124 12/6
—Stock, Ldn, Hind. and afloat... tons	10,306	14,187	 9,957
Tin plates—Charcoal I.C..... box	.....12/9—14/3	..... 13/0—14/6	.....14/6—16/0
Lead—English pig ton	11 17/6—12 0	£11 5—11 7/6	11 7/6—11 10
Spelter—Ord. Silesian ton	£22—£22 2/6	20 2/6—20 7/6	18 12/6—18 15
Quicksilver—(75lb.) bottle	..... £7 15	..... £8 10	..... £8 15
Antimony—Regulus ton	..... £26-£27	£26 10—£27	... £29—£30
Coal—Lyons Wallsend, London ton	..... 13/0	.....15/0	.....17/0

The following are the shipments of pig-iron from Middlesbrough, according to Messrs. Wm. Jacks & Co., Middlesbrough, August 11th, 1904:

DESTINATION.	Last Month to 11th.	Aug. to 11th 1904.	Aug. to 11th 1903.	Aug. to 11th 1902.	7m. ended July 30th, 1904.	7m. ended July 30th, 1903.
Scotland ...	15,612	15,156	20,256	12,810	257,463	300,531
England & Wales ...	4,475	7,481	4,257	3,980	66,104	110,191
Foreign.....	10,998	14,850	8,568	18,509	296,501	309,274
Totals ...	31,085	37,487	33,081	35,299	620,068	719,996

PIG-IRON WARRANT SYSTEM AND THE FOUNDRY.

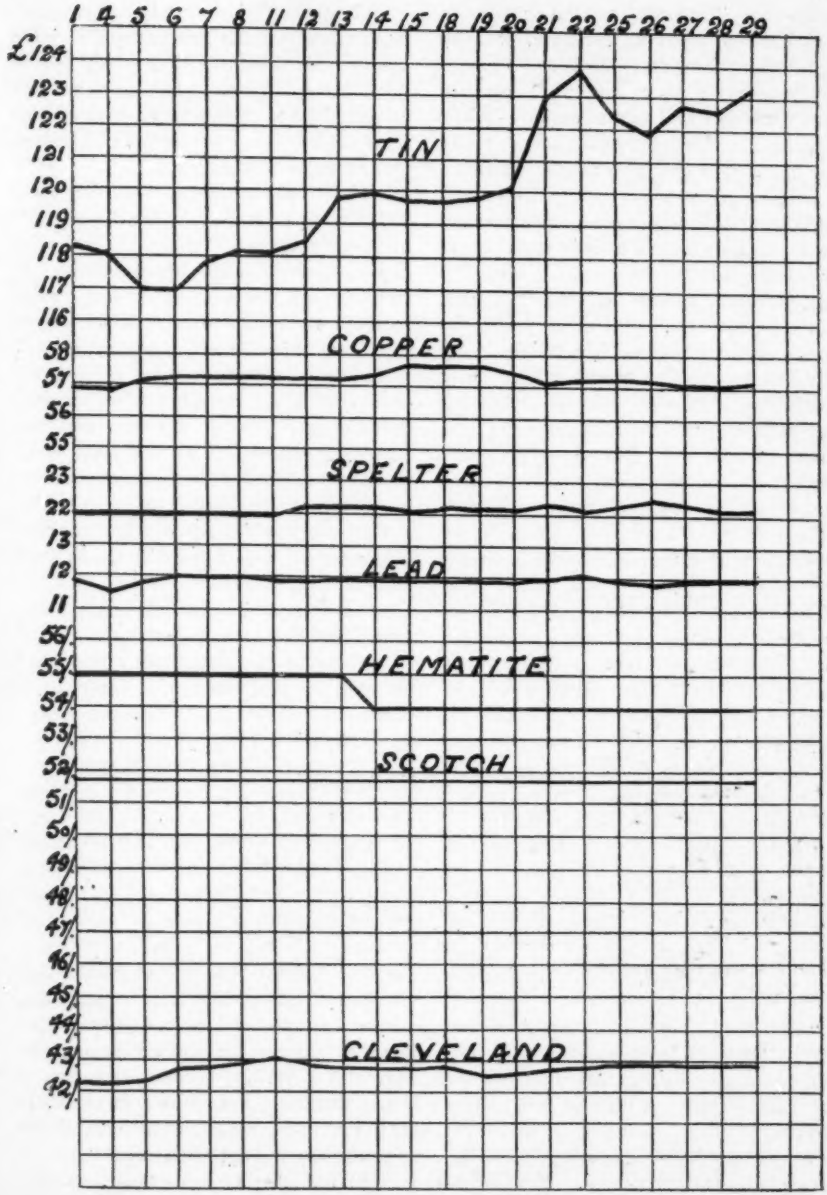
BY GEORGE H. HULL.

(*Continued from page* 36.)

STATISTICS show that the population of this country not only increases enormously, but the consumption of iron per capita increases at a cumulative rate. We consumed about 100 lbs. per capita in 1855; 300 lbs. per capita in 1890; and 500 lbs. per capita in 1902. It further appears that this twofold increase doubles the country's consumption about every ten years, but the yearly increase is not proportionate. For seven or eight years consumption remains practically on an even plane; then it receives an impetus which causes it to be doubled within two or three years, during part of which time we experience what has been designated as a pig-iron famine. After such periods of famine, the succeeding seven or eight years of dulness and plenty has heretofore lulled us into a delusive feeling of security.

For forty years the late Hon. Abram S. Hewitt predicted those enormous increases and they have always been verified. Recently the Hon. Edward Atkinson has predicted that the consumption of iron in the United States will reach 40,000,000 tons per annum between 1910 and 1913. This prediction, like those of Mr. Hewitt, is not a fanciful outburst of imagination; it is simply the result of a mathematical calculation based upon the exact growth of the past, and its fulfilment is as assured as is the future growth and expansion of the country. The law of supply and demand is inexorable. The supply of iron for any given period is the stock on hand at the commencement of that period added to the current production during the period. If in 1910 the stock on hand is one million tons, the production eighteen millions, and the demand forty millions, then the supply will be twenty-one millions short of the demand the first

CHART OF THE FLUCTUATIONS OF THE METAL MARKET IN JULY.



year of the boom, and no human power can prevent another famine.

The past we cannot revoke, but we may profit by its lessons. If we permit the same conditions which have existed for the last 80 years to continue, we will experience the same results. The year 1897 seems a very little while ago; to 1910 will be a still shorter period—hardly time to prepare. If we are to be ready for the next boom, we cannot commence too soon or work too fast. Those who are the first to adopt the Scotch method will get the greatest benefit from it, and when the next period of scarcity and high prices comes, if there are any who have not adopted that system, they will be handicapped, for what iron there is on hand, and what is produced, will naturally go to the consumers who hold binding contracts, in preference to those who hold contracts with the "strike and accident" clause. If, on the other hand, all consumers should from this time on decline to make other than positive contracts, when the next season of prosperity comes we will be equipped with an ample stock of iron. The famine in supply, arbitrary labour strikes, and advances in prices will be prevented, and thereby insure your ability to supply the demand of the country with promptness, with comfort, and with profit. The extra demand created in gathering a reserve supply will be a benefit to producers while it is being accumulated, and to consumers while it is being used.

This question is not only one of great importance to the consumers of this country, but it is one that vitally affects our foreign trade. As long as this country fails to carry a large stock of pig-iron, her foreign trade in iron and steel will be subject to interruptions. In 1895 the United States commenced to export pig-iron, and inside of three years this business grew so rapidly that she was exporting iron to all the manufacturing countries of Europe. When prosperity returned in 1899, the relation of supply and demand in the two countries resulted in an advance of 300 per cent. in the price of pig-iron in Alabama against 65 per cent. in Glasgow. The result was that the export business which we had built up in pig-iron was wrested from us completely by Germany and Great Britain.

For fifteen years the average stock of iron carried in the United States has been less than three weeks' product. During this same period Scotland has carried more than six months' product. Think of the United States attempting to control the iron trade of the world with a stock equal to less than twenty-one days' production!

NEW INVENTIONS.

List specially compiled for THE FOUNDRY TRADE JOURNAL by MR. GEORGE BARKER, Fellow of the Chartered Institute of Patent Agents, Consulting Engineer and Expert, 77, Colmore Row, BIRMINGHAM.

Telephone No. 1,300. Telegraphic Address—"PATENT, BIRMINGHAM."

No. 2,515/1903. Mr. J. SHANKS, Tubal Works, Barrhead, N.B.

"Improved combined melting and heating furnaces." The object is to provide an improved construction of crucible and muffle furnaces, with or without the addition of a lead melting furnace, so that oil or gas may be satisfactorily used as the fuel in connection therewith. The accompanying drawing is a copy of the drawing attached to the inventor's specification, and will be referred to in the course of this short description of the various parts. Fig. 1 is a vertical section, and Fig. 2 a horizontal section of the furnace. A is the crucible furnace in which a crucible (not shown) is supported on the seat B, formed for it by a double arch B^1 of fire-

bricks, the outer ends of which are built into the walls A^1 of the furnace. This forms a firebrick grate, and has spaces or openings B^2 through it for the passage of the ignited fuel. Ports A^2 in the wall A^1 communicate with flue and furnace spaces C^1 and C^2 formed in an outer wall C surrounding the parts, so that the furnace space C^2 is on one side of the crucible furnace A, and has a muffle of oven D of circular section fitted therein. A flue passage C^3 is arranged under the muffle D, so that the latter is surrounded by flue spaces except at a part D^1, which part is blocked. A passage E is formed on this blocked side to lead from the spaces C^1, C_2, and C_3 to a contiguous furnace chamber G containing an ordinary pot G^1 used in the melting of lead, and an exit G^2 leads from this chamber to the chimney.

Gas fuel may be burned in the usual manner in a combustion space A^3, but in this instance oil fuel is employed, the oil being led to the pan H in the bottom of the furnace. The ignited fuel acts on and passes through the space B^2 in to arched grate B^1, causing the latter to become highly incandescent, which brings about perfect combustion of the fuel, and enables it to act very efficiently on the crucible.

The products of combustion pass through the ports A^2 into the spaces C^1, C^2, heating the muffle D, and imparting a preliminary heat to any pot placed therein, so that less heat is afterwards required to thoroughly heat the metal when the pot is transferred to the crucible furnace. As the flue spaces C^2 are blocked at D^1, some of the products of combustion are compelled to pass under the muffle by way of the passage C^3 to the outlet E, thus increasing the efficiency of the action of the gases on the muffle.

The hot gases pass from the outlet E to the chamber G, where they act on the lead-melting pot G^1, after which they pass on through the exit G^2 to the chimney.

No. 24,915/1903. W. Reuter, Westphalia, Germany.

"Tilting device" for foundry ladles. This invention does away with the necessity for employing a separate tilting device, and brings about the tilting of the ladle by means of the device employed for lifting. In the following brief outline of the action of the contrivance, reference is made to the appended illustration.

The ladle filled with the molten iron is raised slightly from the ground, moved close to the casting mould or funnel, and again raised by means of the cranes. As this is done, the trunnions A attached to the ladle come in contact with the nose B, and slide along the curved groove C, whilst the trunnions D, which are firmly gripped by the hook, move along the guiding groove E. By this means the ladle is slowly tilted, but—and this is claimed to be an important advantage—the pivotal point around which the tilting takes place lies in the discharge spout, and not, as in all other devices, in the middle of the hook which supports the ladle. This arrangement obviates the necessity of constantly moving the ladle, and with it the crane from place to place while casting takes place, to ensure the spout remaining in the right position above the funnel. The contrivance also gives an equally strong outflow of molten metal throughout the whole process of casting.

No. 9,689/1903. J. B. Alzugaray, London. "Crucible Furnaces."

This furnace, it is claimed, effects a considerable saving in time and fuel used in the reduction of metals. In the following brief description reference is made to the accompanying drawing, on which Fig. 1 is a vertical section on the line 1—1 of Fig 2. Fig. 2 is a sectional plan on the line 2—2 of Fig. 1, and Fig. 3 is a sectional elevation on the line 3—3 of Fig. 2.

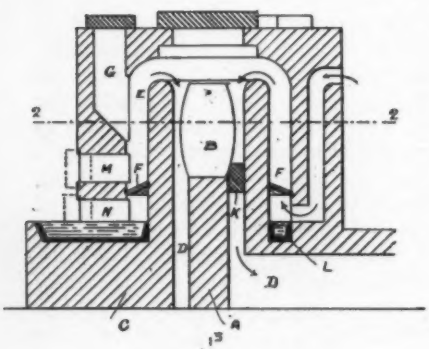
A pedestal or pillar A is built upon a suitable foundation, for the reception of the crucible B, and is surrounded by the wall of the furnace C, the annular space

D between the wall and the pillar forming a flue for the gases of combustion. In the wall is a second space E, which constitutes a fire chamber, and is provided at its lower part with a grate F, to which fuel is conveyed by means of the charging openings G. Air passage H are arranged so that the walls, heated by the fire, warm the air on its passage to the grate. J is an opening by which the crucible is inserted or removed from the furnace, and K are centring blocks built into the wall C. An annular water trough L is placed at the bottom of the space E below the grate, and is connected to a radial trough which extends outside the furnace as seen at Figs. 1 and 2. M represents stoking-holes, and N is a manhole.

The water contained in the annular trough becomes evaporated by the heat, the steam passing into the combustion chamber, and, being decomposed by the incandescent fuel, produces a certain amount of water-gas.

The action of the furnace is as follows.

FIG 1



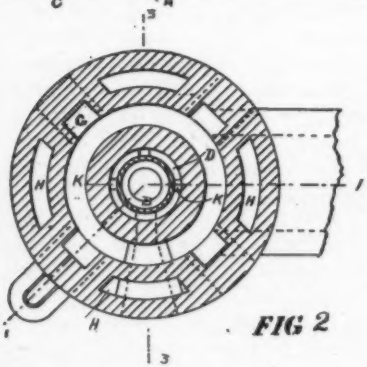
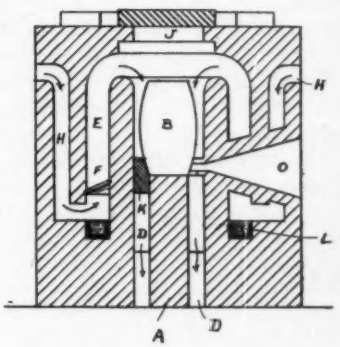


FIG 2

FIG 3



The fire being lighted, and the chamber E filled with fuel, the blast is turned on, and the flames and heated gases pass over the top of the wall C and down past the crucible, which is thereby heated.

The crucible is provided with a tapping hole near the bottom, and a passage O is formed in the wall of the furnace, by which the molten metal may be drawn off.

Sara Spedito THE FOUNDRY TRADE JOURNAL *per il periodo di un anno in qualsiasi paese, franco di posta, dietro pagamento di* 9 *franchi e* 50 *centesimi. Della somma deve essere rimessa con vaglia internazionale o con cheque pagabile in Inghilterra.*